BIOLOGY IN THE SERVICE OF MAN

DISCOVERING BIOLOGY

Book Four

BIOLOGY IN THE SERVICE OF MAN

(Professor R. E. Holttum)

Life is certainly a struggle for existence in this environment—
jungle in Malaya

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F. TYRER, M.A., B.Sc.

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F. TYRER, M.A., B.SC.

Book One: *The Variety of Life*
Book Two: *The Energy of Life*
Book Three: *Going on Living*
Book Four: *Biology in the Service of Man*

BOOK FOUR

First published 1956
Second Impression 1957
Third Impression 1959
Fourth Impression 1961
Fifth Impression 1964

Printed in Great Britain by
Jarrold and Sons Ltd, Norwich

WHAT THIS BOOK IS ABOUT

THIS is Book Four of a series of four books called DISCOVERING BIOLOGY. In the first book, *The Variety of Life*, a study was made of a few of the common plants and animals that are found almost everywhere. In the second book, *The Energy of Life*, we discussed what is going on in living things—how they are built, and move, why they need food and oxygen, and what happens to the food and oxygen. We also discussed the blood or transport system and the problems of getting rid of waste and keeping warm. In the third book, *Going on Living*, we studied those processes which are mainly responsible for helping living things to go on living. We discussed what directs and controls all that is going on inside a living thing, and how living things get to know, or respond to, what is happening inside and round about them. We also learned something about the ways in which living things reproduce, develop, and grow, and how new types of living things may arise.

We should now have quite a sound knowledge of Biology, particularly about the working of the human body, and of some of the things we can do to keep ourselves in a healthy state.

As Young Biologists we must do what all good scientists do; we must learn how man's discoveries in Biology are used to benefit mankind. In this book, *Biology in the Service of Man*, we shall discover how biological knowledge is or can be used to improve the health of human beings and lead to the greater happiness of mankind everywhere. This is how the discoveries of science should be used—for the benefit of mankind, and not for his destruction. We shall find out what can be done to improve the living conditions of man, animals, and plants. We shall make a study of bacteria so that we can understand more clearly how man fights against disease in himself, in animals, and in plants. We shall learn how biological knowledge is used to maintain the health of the communities in which man lives, and to improve the conditions in which man works. We shall find out how biology is applied in agriculture, to produce better plants and animals, and to increase the world's food supply. And since the majority of you in a few years' time will be thinking of marrying and having a home of your own, we shall learn how a knowledge of biology will help you to make that home a healthy and happy one.

FRANK TYRER

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(Sport and General Press Agency Ltd.

(Mirrorpic)

Good and bad environment. Which children have the better chance of health? What are the others missing?

CHAPTER ONE

HEREDITY OR ENVIRONMENT: WHICH?

BEFORE you study this chapter you will find it very helpful if first you read again the chapter in Book Three entitled "Variation and Heredity; New Plants and Animals". In that chapter we found that it was fairly easy to say how much variation in plants and animals is due to environment (that is, the conditions under which they are living), and how much is due to heredity. Scientists can easily carry out experiments with plants and animals, and produce several new generations for observation during a short period of time.

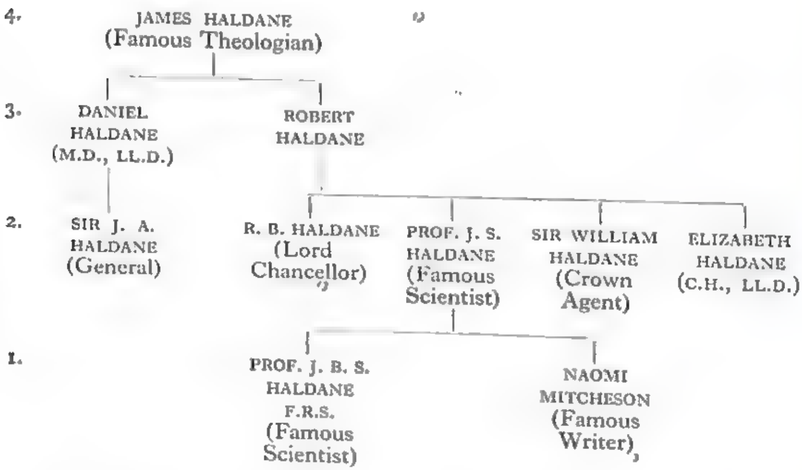
But when we come to human beings it is much more difficult. It is not easy to perform experiments, and it takes a very long period of time for even one or two generations to appear. For example, it is not easy to say whether a thin person has inherited his thinness from his parents and grandparents or whether it is due to malnutrition. We should have to find out whether his parents, grandparents, great-grandparents, brothers and sisters, aunts, uncles, and cousins were thin, and also what he usually ate for his meals, before we could attempt to give an answer.

People have very queer ideas about heredity, some of which are entirely false. Let us examine some of these ideas.

CAN INTELLIGENCE BE INHERITED? When people are discussing some clever child we often hear someone say:

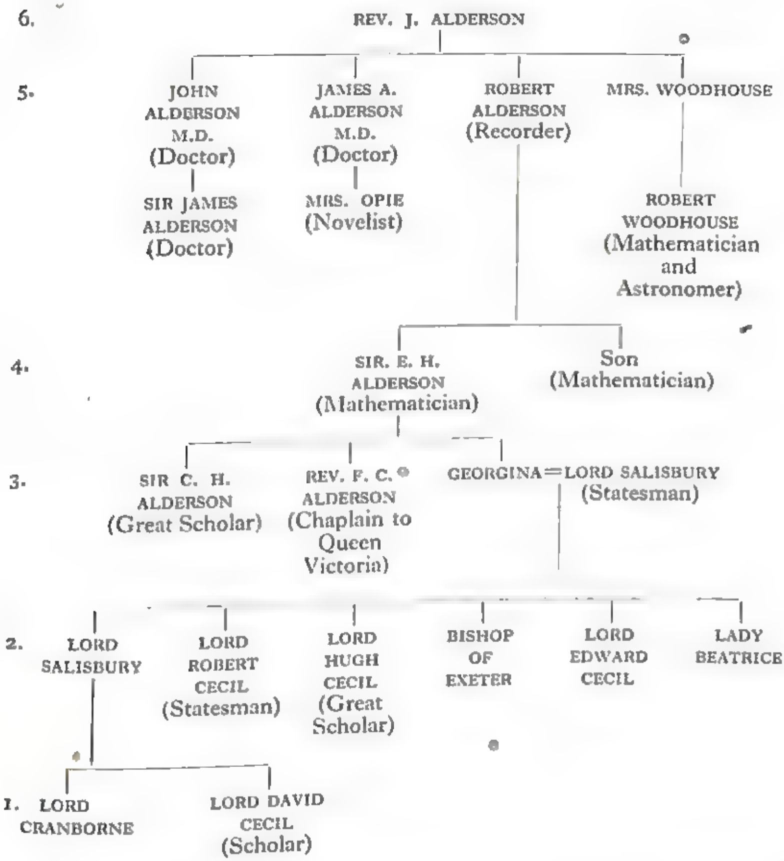
"Oh! it runs in the family; his father was very intelligent." Put scientifically, this statement means that the boy is clever because he received from his father *genes* which made him intelligent. (You will remember that every human being receives twenty-four chromosomes from his father and twenty-four from his mother, and that the gene is a part of the chromosome which carries a characteristic from one generation to the next.) But do we inherit intelligence from our parents? We do not know definitely. There are some families which seem to show it can be inherited. Let us look at the family tree of two well-known families.

One of the best-known of modern British biologists is Professor J. B. S. Haldane. Here are some of his parents, grandparents, great-grandparents, uncles and aunts and great-uncle:



From this it does look as if Professor J. B. S. Haldane had inherited his intelligence.

Let us look at another famous family, the Salisbury family.



These tables do seem to show clever people in each generation, and it does look as if intelligence has been inherited by each generation from the one before it. But we believe that environment also plays its part. A child

may be quite clever, yet if he is not encouraged to use his talents, or if he comes from a home where he is not given much help, or if he fails to get a good education, then instead of becoming a bright scholar the child may be frustrated and take up some job in an office or factory where his cleverness is not used to the fullest extent.

Some American scientists studied a large number of children, and found that the children of business managers, doctors, and teachers were usually more intelligent than the children of labourers, farmhands, and unskilled workers. What are we to think from this? Are we to say that the children of business managers, doctors, and teachers inherited their intelligence from their parents, while the unskilled labourers and farmhands are not intelligent, and therefore their children are not intelligent? Or are we to say that very likely the children of the unskilled labourers and farmhands are just as intelligent as the children of business managers, doctors, and teachers, but that they do not have the same chance and encouragement? Which do you think is the right answer?

You see how difficult it is to decide how much is the result of heredity and how much is the result of *environment* (the conditions under which a person is living). You will also see how very important it is that everything should be done to secure good living conditions for everybody. That is the aim of all social services. Good government tries to make sure that everybody has the best conditions for living—good education, good houses, adequate wages, good working conditions, efficient health services, and plenty of opportunity for healthy exercise of brain and muscles.

This is really a very important matter for everybody, so let us consider it a little further. Suppose we have two

(Henry Grant)

(Mirrorpic)

Which children have the better start in life? What are the others missing?

children, Eric and Robert, both of whom started off at birth with the same degree of intelligence. Further, let us suppose that Eric is brought up in a fine modern house with a lovely garden, plenty of fresh air and sunshine, and suppose that his parents are able to provide him with good food, and a good education, to give him all the books and exercise he requires, and that they also see that he gets sufficient sleep. Let us suppose that Robert lives in a home where the family are crowded together in one or two rooms, with no garden attached, and suppose his parents cannot provide him with adequate food or the books and exercise he needs, and do not see that he gets sufficient sleep. Which boy, Eric or Robert, do you think is going to make more progress? Which do you think is going to be frustrated more?

To make sure that any boy or girl who is intelligent will not be prevented from being educated because of the poverty of his parents, we make education free for all children.

CAN FEEBLE-MINDEDNESS BE INHERITED? Have you ever heard the terms "feeble-minded person" or "mentally deficient person"? Such a person is one whose brain and nervous system do not seem to function or work as they should do, and so the person shows very little intelligence. We may now ask: "Is feeble-mindedness inherited? Can it be handed on by parents to their children?" Here again, scientists have not yet got the complete answer. We do know that certain types of feeble-mindedness can be inherited, and we also know that these types of feeble-mindedness are due to *recessive genes*. That is, a person can inherit them from one of his parents and so have them in the chromosomes of his cells and yet show no signs of feeble-mindedness. But if a baby receives genes for

feeble-mindedness from its mother *and* also from its father, that baby will be feeble-minded. It is a result of the combination of genes from *both* parents.

You will see also that it is possible for two intelligent people to have a feeble-minded child. If the father has a recessive gene for feeble-mindedness in his chromosomes and the mother also has such a gene in her chromosomes, it is quite possible that one or more of their children will be feeble-minded if they receive a gene for feeble-mindedness from the father *and* from the mother. If the children receive a gene for feeble-mindedness from only *one* parent, these children will not themselves be feeble-minded, but they will have in their chromosomes the recessive genes for feeble-mindedness which they can hand on to their children.

It is now generally accepted that mental deficiency is inherited. But that does not mean that every child who is mentally backward has inherited mental deficiency. For the child may not be deficient or lacking in mental powers, but because of such handicaps as lack of sleep, illness, absence from school, malnutrition, or poor home conditions, he may not be able to use his brains as efficiently as he could, and that is why he is mentally backward. Even an intelligent child whose home conditions are against him or who has been away from school for a long time, may not be equal mentally to other children of his age. He can be helped greatly if the cause of the trouble is removed.

CAN PERSONALITY BE INHERITED? What about our behaviour and personality? Are they inherited, and are they influenced by our surroundings and conditions of living? Here again, we still do not know the full answer. But it is certain that to some extent we do inherit our personality

(Fox Photos, Ltd.)

Even at this early age some resemblance can often be seen between a child and its mother or father

and also our manner of behaviour. I expect you have heard people say that a certain child acts and behaves just like his father or mother. No doubt you have heard people talking in this fashion: "There's Ruth Mackinley. She's a lovely young woman; so kind and gentle, just like her mother." And, indeed, it is probable that Ruth did inherit her kindness and gentleness from her mother. But again one's manner of behaviour and one's personality can very often be altered by outside influences. Even a

kind, gentle person can under certain circumstances be completely changed into an ungenerous, less gentle person.

WHY ARE MORE MEN COLOUR-BLIND THAN WOMEN? When we come to bodily or physical characteristics we can be more certain of our answers. Let us look at an example. Some people, you may have heard, are colour-blind; that is, they are unable to see colours and everything appears to them in varying shades of grey. Colour-blindness is inherited and is far more common in men than in women. Let us see why this should be the case.

We already know that the cells of a woman's body contain twenty-four pairs of chromosomes, i.e. twenty-three pairs of chromosomes plus a pair of X chromosomes. We also know that the cells of a man's body contain twenty-four pairs of chromosomes, i.e. twenty-three pairs of chromosomes and a pair of unlike X and Y chromosomes. The Y chromosome found only in a man's cells is smaller than the X chromosomes and contains fewer genes.

Now, since it is the X and Y chromosomes which determine the sex of a person, we call them the sex chromosomes, and it is always in these X and Y chromosomes that we find the *dominant* gene responsible for normal vision, and the *recessive* gene responsible for colour-blindness.

If a woman has a recessive gene for colour-blindness in one of her X chromosomes, she may have a gene for normal sight in the other X chromosome. Since this is a dominant gene it will overcome the effect of the recessive gene causing colour-blindness: she will have normal vision and be able to see colours. This is what usually happens. For a woman to be colour-blind she would need to have the colour-blindness gene in both of her X chromosomes. This is rare.

In the case of a man, the X chromosome may carry the colour-blindness gene, and since the Y chromosome is small and has only a few genes in it, the gene for normal vision may be missing, and therefore the colour-blindness gene is not overcome and the man will be colour-blind. You see, then, that only one gene for colour-blindness is needed to make a man colour-blind, while two are required for a woman to be colour-blind. Therefore more men are colour-blind than women.

The same facts apply to another inherited physical defect, called haemophilia. The blood in a person who suffers from this does not clot properly, so if he receives a cut he goes on bleeding. The gene responsible for haemophilia is carried in the sex X and Y chromosomes, and is therefore also more common in men than in women. Fortunately, it is a somewhat rare disease. A very interesting point about this disease is that Queen Victoria, who herself was not a "bleeder", did have a recessive gene for haemophilia in her chromosomes. Some of her children received this gene from her and some did not. Two of her daughters married into the royal families of Russia and Spain, with the result that the sons in these families were "bleeders", and in 1938 the Crown Prince of Spain bled to death as the result of wounds received when involved in a motor accident.

SHOULD COUSINS MARRY? At one time, before we knew anything about chromosomes and genes, people believed that if two cousins married, any children they had would be deaf and dumb, or blind, or feeble-minded. Although we now know that this is not true, a number of people still cling to this belief. But there is one point which needs considering when cousins marry. Since cousins are descended from the same grandparents, it is likely their

chromosomes will carry similar genes. Thus, if one of them has the gene for haemophilia or feeble-mindedness, then there is a good chance that the cousin will have the same gene. If these cousins marry, any children they may have run greater risk than usual of receiving two genes for these defects, and therefore their children are more likely to have these defects than those of married people who are not cousins. Of course, if cousins can trace their descent many generations back and find there is no trace of any hereditary defects, such as feeble-mindedness, colour-blindness, etc., there is no reason why they should not marry.

There is another point worth considering in marriages of cousins. It is possible that the cousins have a gene producing some good quality. If this is so, and the cousins marry, their children are far more likely to have the good quality than usual. Charles Darwin, the great English biologist, married his cousin, and their children were all very intelligent and became celebrated.

CAN DRUNKENNESS AND TUBERCULOSIS BE INHERITED? Some people have quite false ideas about what can be inherited. It is often said that if a drunkard has children they will inherit their parent's love of alcoholic drinks and eventually become drunkards. These people seem to think that if the parent goes on drinking and drinking alcohol, it will have some effect on his genes that will be handed on to his children. In the same way, some people believe that a crazy desire for drugs can be inherited. This is not true. The genes cannot be altered by the habits of man, and the children of a drunkard can be just as normal as the children of a non-drinker.

Such habits as drinking, smoking, and taking drugs are called *acquired habits* or *acquired characteristics*. They are things which a person has got into the habit of doing over

and over again. Such an acquired characteristic cannot be passed on to the children by heredity. If the children of a drunkard become drunkards themselves it is not because they have inherited the habit, but because they have seen their parents drinking to excess; they have been brought up badly and have acquired or learnt the habit. If they had been taken away from their drunken parents and brought up in a good home perhaps they would not have learnt the habit.

In the same way, there are many people who think that tuberculosis and other diseases can be inherited. This is not true. Few diseases are inherited. What some doctors and biologists do say, however, is that although tuberculosis cannot be inherited, it is possible that a weak condition of the breathing system may be inherited, and therefore the person will have a tendency to get tuberculosis easily.

On the other hand, there are some doctors and biologists who say that this is incorrect. They believe tuberculosis is a social disease and is due entirely to poor conditions of living. The real cause of tuberculosis, they say, is overcrowding, bad housing, malnutrition, and poverty.

Here, you see, is another example of how much we are still in the dark about heredity and environment. We cannot yet say how much of a person's character, behaviour, and physical condition is due to the genes he received from his parents, or how much is due to the circumstances in which he is living. We know a good deal about it, but we still have much more to learn.

Perhaps the silliest and most unscientific idea some people have is that the embryo baby developing in the mother's body can be influenced by what she sees around her. It is often said that if a pregnant woman looks at

many good pictures or listens a great deal to good music while the baby is developing inside her uterus, the baby will become an artist or musician. This is utterly untrue. Just as silly is the belief that a baby with a red "strawberry" mark on its skin got it because its mother ate strawberries before the child was born!

The baby's character is decided immediately the egg is fertilised by the sperm, for it receives then from both its parents the genes which decide its character. But certain things can influence the embryo baby while it is still in its mother's body. If the mother is not getting good food in sufficient quantities, this lack will affect the baby. For example, the baby will have insufficient calcium supplied to it and it will not form good teeth and bones. Do you see the difference between saying that the child has inherited bad bones and saying that its mother failed to give it before birth the right food to make its bones grow properly?

IS THERE A SUPERIOR RACE? When Adolf Hitler and the Nazi Party were in control of Germany from 1933 to 1945, they were constantly boasting about the superiority of what they called the Aryan race over all other races of people. They were regularly denouncing the Jews as an inferior race. Because of this supposed superiority the Nazi Germans thought they were destined to rule the world. Besides the Nazi Germans other people have often regarded themselves as superior to other races. The negro is often looked upon as being very inferior to the "white man".

We must ask ourselves some questions. What is meant by a race of people? Is there a pure race? Is one race of people superior to another race?

By a race we mean a group of people who intermarry

A

B

C

A An English child and his mother who live on the coast of Cornwall

B This Tibetan mother is used to carrying her baby on her back

C This mother and her baby live in Kenya on a coffee farm with many other workers and their families

(Photos Picture Post Library)

and who possess certain bodily characteristics which are not possessed by any other group of people. With this in mind we might say the blacks are one race of people, the whites are another, the yellow peoples are another, and the red peoples (Red Indians) are a fourth. But if we look a little more closely we should see it is not so easy as all that. Some "whites" are darker skinned than some "blacks" or "yellows". So it is very difficult to divide people up into races by their colour since there are such

variations in each group. It is just as difficult if we take other characteristics. We may say that we can tell a negro by his kinky hair and flat nose. But many "whites" have kinky hair and flat noses!

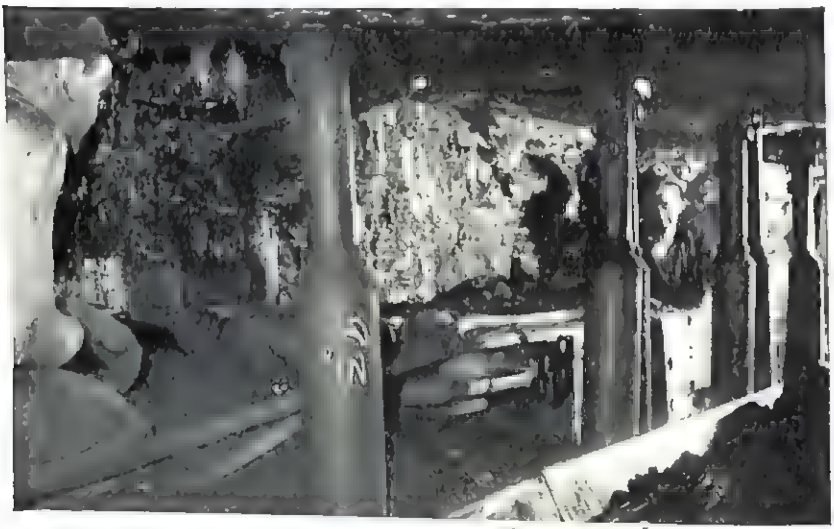
When we take into account what has been happening through history we soon begin to find that it is practically impossible in this world to find a pure race. We believe that man as we know him today appeared about 50,000 B.C. round about Mesopotamia. Descendants of this type of man soon began to spread throughout the world, and various mutations which occurred produced men with certain different characteristics. As time went on these differing tribes of men intermarried. Because of this intermingling and intermarrying, there is no such thing as a pure race. For example, the English are a mixture of all the people who have invaded and settled down in England: Ancient Britons, Romans, Anglo-Saxons, Vikings, Normans, and a few others. An Englishman must have in him genes which have been handed down to him from all these various peoples.

As far as biologists have been able to prove, there is nothing to show that one group of peoples is superior to another. Intelligence tests have shown that Chinese and Japanese children can be just as intelligent as American and European children. Just as there are intelligent whites and unintelligent whites, so, of course, there are intelligent blacks and unintelligent blacks. Frequently when an intelligence test has been set to whites and blacks in America, there have appeared to be more intelligent whites than intelligent blacks. But this may not be due to heredity; it is almost certainly due to the fact that the whites usually live under better conditions and in a better environment than the blacks.

It is often said that the English are a race of seamen.

Because of the exploits of Drake, Raleigh, and Nelson, some English seem to think they have inherited a superior skill in seamanship. This is not so. It is only because, living on a small island, they have greater opportunity for learning seamanship. But there is no reason to believe that just because he is English, a Wigan man makes a better seaman than a man from Switzerland which has no sea-coast at all. But it is much more probable that a man from Wigan will have a better chance of going to sea than the man from Switzerland. So here again, it is not a matter of heredity, but of opportunity and environment.

Besides better living conditions and better education, other conditions which have enabled the European or white races to "appear" more intelligent are the temperate



(By courtesy of the National Coal Board)

Mining coal is a dangerous and dirty but skilled job. This mechanical cutter and conveyor does more work with less physical effort, and thus makes possible higher wages and a higher standard of living

climate which makes for easier working conditions, the development of the natural resources—coal, oil, minerals—which has enabled them to do more work with less physical effort, and an intensive cultivation of good soil which has given them abundant food.

Thus we have found that there is probably no such race as a pure race and that no people are naturally superior. But some peoples, just like some individuals, have better opportunities and circumstances than others, and some peoples, like some individuals, do make better use of their opportunities than others.

QUESTIONS TO ANSWER AND PROBLEMS TO SOLVE

1. Look up in a dictionary, encyclopaedia, and books on biology, the meaning of these terms and enter them in your GLOSSARY: *chromosomes*, *gene*, *recessive*, *dominant*, *heredity*, *environment*.
2. Describe any example which seems to prove that intelligence in human beings is inherited.
3. Do you know of a case where the influence of a good home has been of great benefit to a boy or girl in developing his or her talents? If so, describe it fully.
4. Which do you think has the greatest influence on a person's character and development—heredity or environment? Or do you think both are important? Give reasons.
5. Make a list of the services good government should provide to maintain or improve the standard of living conditions.
6. Do you think the sons or daughters of a school teacher or university professor will become more intelligent than the children of a dock labourer or coal miner?
7. Look in a dictionary or encyclopaedia for the meaning of *feeble-mindedness* and *mentally defective*. What is the difference between "mental deficiency" and "mental backwardness"?
8. Should feeble-minded people marry and have children? Give reasons for your answer.
9. What is meant by *colour-blindness* and *haemophilia*?

10. Why do more men suffer from colour-blindness (and haemophilia) than women?
11. Tuberculosis often runs in families. Since this may not be due to heredity, what might be the reason?
12. What is meant by an *acquired characteristic*?
13. Can an acquired characteristic be inherited?
14. Is our social behaviour inherited or due to environment?
15. Why can there be in the same family both a clever, sociable child and also a dull, unsociable child?
16. Is there such a thing as a pure race? Explain your answer.
17. What was wrong with the Nazi theory of a superior race?
18. Do you think that white people are more intelligent than black or yellow people?

PROJECT WORK

1. Collect pictures of different races of people. Arrange them into groups according to certain characteristics and compare them. Make a book of your work or make posters.
2. Try to trace back your own family tree. Collect also family trees of any well-known family in your district.


(From McLean and Cook, "Textbook of Theoretical Botany", Vol. I, Longmans)

Many of the troubles of farms and gardens are caused by parasite fungi: the "damping-off" of these seedlings, for instance

CHAPTER TWO

PARASITES AND PARTNERS

LIFE has often been called a struggle for existence. Certainly plants and animals have to struggle to get food, for there is much competition for food. We have already found that plants use simple materials like water, carbon dioxide, and minerals for their food, and from these manufacture complicated foodstuffs like carbo-hydrates, proteins, and vitamins. Animals cannot manufacture foodstuffs: they have to hunt for them and work hard to get them.

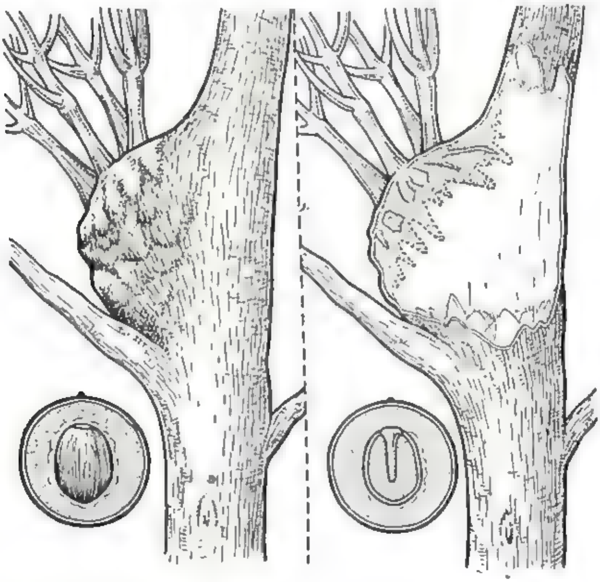
There are some plants which do not make their food, and some animals which do not search or work for their food. They take it from other living animals and plants without working for it and without giving anything in return for it. Such animals and plants are called *parasites*. The plant or animal from which they take the food is called the *host*.

PLANT PARASITES. Most parasitic plants do not contain chlorophyll, the chemical which makes leaves green, and which a plant must have in order to make food in sunlight. Because of this lack, parasitic plants cannot make their own food and have to take it from other living plants or animals.

Fungi and *moulds* are parasitic plants which may use other plants or animals as hosts. Perhaps you have seen a bracket fungus growing on the side of a tree. The part of the fungus you see is only the spore-forming part. Extending through the trunk are the millions of tiny white threads of the fungus which are slowly stealing the

food which the tree has stored up. In time they will kill the tree. By then the spores formed in the bracket part will have been scattered to form new fungi on other trees.

Another plant parasite is the *mistletoe*, which is usually found growing on the branches of an oak or apple tree. It feeds by sending suckers into the water tubes of the host plant and "steals" the water and chemicals which the host had obtained for itself. The mistletoe is only a partial parasite, for with the chlorophyll in its green leaves it can manufacture some of its own food.



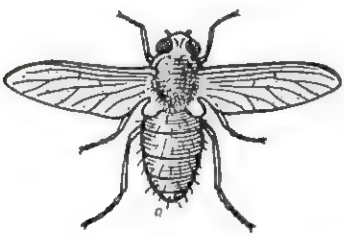
(Redrawn from Skaife: The Outdoor World, Book 6)

The mistletoe fixes itself to its host with pegs that penetrate the wood as far as the vessels containing the sap of the tree. In the left hand circle a mistletoe berry has been cut in half to show the seed inside the berry; in the right hand circle the seed too has been cut in half to show the little green peg embedded in the food material.

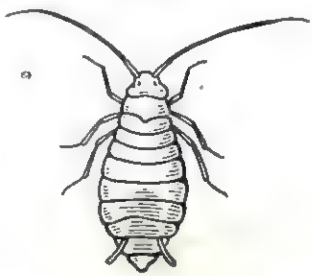
ANIMAL PARASITES. Have you ever seen a dead caterpillar with a number of tiny yellow cocoons round it? It has been killed by a parasite fly, the *ichneumon fly*. The female ichneumon fly settles on the caterpillar, pierces through its skin with a sharp needle-like egg-laying tube, and lays her eggs inside the body. The grubs which hatch out from the eggs feed on the juicy inside of the caterpillar. It is only when they are full grown and ready to emerge that they eat the vital parts of the caterpillar and so kill it.

Another fly which lays its eggs inside an animal is the *warble fly*, but this chooses a much larger animal than a caterpillar. The warble fly lays its eggs beneath the skin of an ox or cow. The maggots which hatch out feed on the flesh. This parasite is a great pest, for it spoils the flesh for eating purposes and, by forming lumps or "warbles" in the hide, makes that unfit for use as leather.

Some insects are parasites on plants. The *greenflies* and *blackflies* which are found in hundreds on roses and beans are parasites. The mouth parts of the greenfly are made for piercing into the soft buds and stems and for sucking up the plant juices. They do a great deal of damage to plants. Gardeners spray their plants to kill these flies.



Warble-Fly

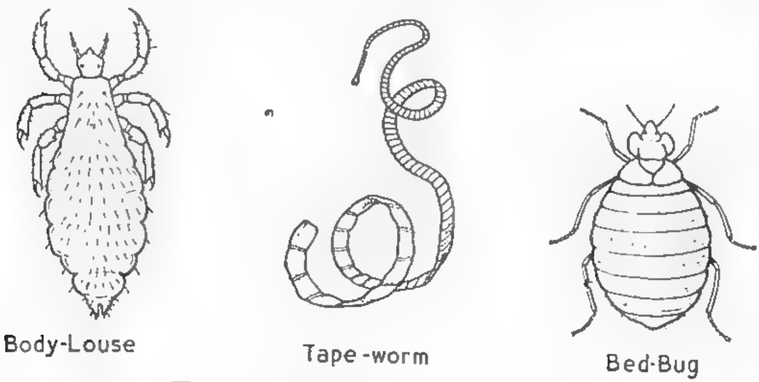


Greenfly

Parasite insects give trouble to both farms and gardens

Some insect parasites give a great deal of trouble to man, and are very often the means by which diseases are carried. One of the most unpleasant of such insect parasites is the *bed-bug*, which is usually found in dirty houses. Because of its flattened body, it can live in tiny cracks in the wall-paper, floor, or skirting boards. As its name indicates, it is also found in bed-clothes if these are not kept clean. The bed-bug feeds by piercing the skin of a person with its jaws and then sucking his blood. If the bed-bug has been feeding on the blood of a person infected with some fever, it may spread the bacteria, causing the disease in the next person it bites. Clean houses and clean clothing prevent bed-bugs from living and breeding, but if they do get into a house they can be killed off by spraying with Gammexane or DDT. The local Health Department will gladly give advice on the best measures to be taken against pests like the bed-bug.

Other distasteful parasites on human beings are the *head-louse* and the *body-louse*. Usually they are only found on dirty people. They can usually be avoided by always keeping body and hair scrupulously clean. But



Three parasites on human beings

even a clean person can get lice by mixing with infested persons. The head-louse lives in the hair and lays its eggs or nits on the hairs. Both kinds of lice feed like the bed-bug. Where they "bite" or pierce the skin, irritation is set up. If the lice are from some person infected with disease they may transmit some of the disease bacteria as they feed. Also, the itching makes the person scratch, and this brings more troubles. Both kinds of louse can be destroyed by applying lethane oil. Head-lice must be combed out every day with a small-tooth comb.

There are other forms of lice which are parasites on animals. These cause irritation to the animals and may even kill them. Poultry, for example, are attacked by the fowl-louse. Dogs which are not kept clean may become infested with lice.

Fleas are insect parasites too. Again, these parasites are usually found only on dirty people or animals, but they may use their powerful legs to jump on to a clean person. The best way to keep free from fleas is to be clean, but if one does jump on you and makes itself felt, then catch and kill it as soon as possible. Fleas also obtain their food by piercing the skin and sucking blood. We believe that the Black Death and the Plague, about which you have read in your history lessons, were spread by rats and the fleas which fed on them. Rats, like human beings, can get the plague, and the fleas from one infected rat will soon spread the infection to others.

Insects are not the only parasites on plants, animals, and human beings. Some of the worst parasites are worms which live right inside their hosts.

One of these worms, the *tapeworm*, may be many feet in length. For part of its life it lives in the muscle of a pig. If the pork from this pig is not cooked sufficiently and is eaten, the tapeworm passes into the person's

intestines. Here it attaches itself by means of little hooks and suckers round its head and feeds on the digested food passing through the intestines.

So far we have considered animals as parasites which steal their food from other living things. There are other kinds of parasites which do not take food but use other animal's belongings without giving anything in return. There is one very familiar example of this. The cuckoo does not build a nest but lays its eggs in other birds' nests. Perhaps you can think of other animals which are parasites just like the cuckoo.

(*Eric Hosking*)

A young cuckoo being fed by a reed-warbler. In what way is the mother cuckoo a parasite?

PARTNERS. So far in this chapter we have talked about animals and plants which are enemies of other animals and plants. But there are many examples of friendship or partnership amongst animals and plants in which the partners help one another.

A very good example of this is found in the common hermit crab. The hermit crab is soft-bodied and it protects itself by fixing its body inside an empty whelk-shell which it carries about with it. Very often a sea anemone attaches itself to the shell in which the crab is living. The *hermit crab* and the *sea anemone* are partners. Sea anemones are well provided with powerful stinging tentacles, and other creatures keep away from them. Some

(Harold Bastin)

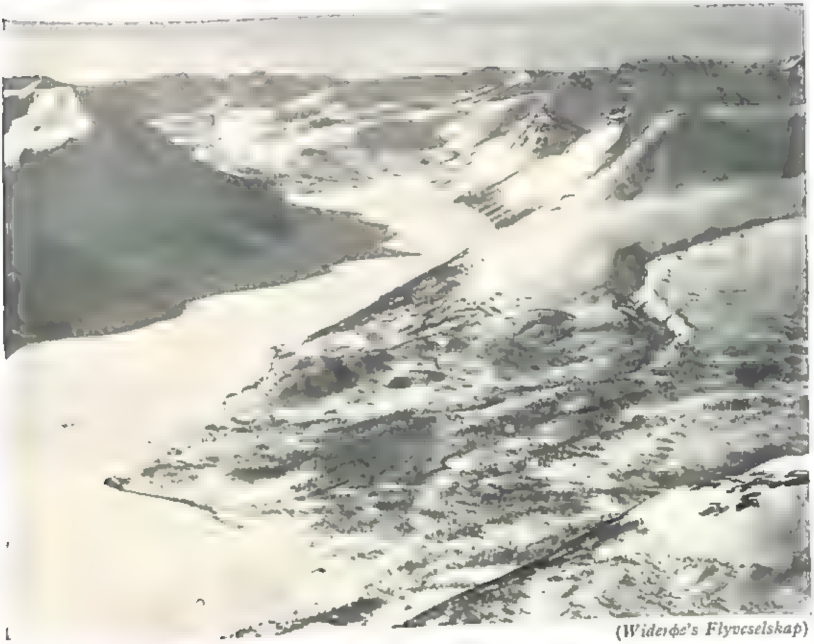
Hermit Crab with Sea Anemone on its back

of these sea creatures may be enemies of the hermit crab. Thus he is protected by the presence of the sea anemone. In return, the sea anemone gets scraps of food from whatever the hermit crab is eating. Sea anemones have little means of movement and so cannot go in search of food. The sea anemone on the hermit crab's shell is carried about and so can get a better supply of food. When two animals live together like this and help one another, we call such a partnership *symbiosis*. Strange to say, another partner is often found living in the shell along with the hermit crab. This is a worm which also feeds on the bits of food which float about when the hermit crab is feeding.

I expect you know the hydra, a tiny animal which may be found living on pond weed. Some hydras appear to be coloured green and are known as *green hydra*. Actually the green colour is due to microscopic single-celled plants living in the protoplasm of the hydra. These plants are green because they contain chlorophyll and are therefore able to make complex foodstuffs from carbon dioxide, minerals, and water. As the cells of the hydra are busy at work they produce carbon dioxide and other waste products. The green plants use this carbon dioxide and the waste products as food and produce complex foods such as proteins and carbohydrates. In this process oxygen is also formed. The hydra makes use of this oxygen and also receives some of the excess carbo-hydrates and proteins, which it uses for building up its body and to provide energy. This is a remarkable example of symbiosis or partnership amongst animals and plants.

When you have been out for a country walk you will probably have noticed the green growth which covers the bark of trees, old gates, and even stones. This growth consists of *lichens*. When examined under a microscope, lichens are found to consist of a fungus composed of

colourless threads of protoplasm. Lying imprisoned in these threads there are single-celled green algae containing chlorophyll. We have already seen that fungi cannot make their food like ordinary plants. This particular fungus makes use of the imprisoned algae which can in sunlight make food, with the aid of the chlorophyll, out of water and carbon dioxide and minerals. At first this looks as if the fungus is a parasite on the algae, but the algae do benefit to some extent. They are protected by the surrounding threads of the fungus and are thus able to live under conditions which would otherwise be impossible for them. Thus we find lichens growing where other



(Wideröe's Flyveselskap)

The long Arctic winter of intense cold, biting winds and little daylight make conditions difficult for any but the simplest forms of plants

plants could not exist, on bare rocks and in the cold lands of the Arctic Circle, for instance.

If you dig up a lupin or pea plant you will find a number of tiny swellings on the roots. These are produced by bacteria living in the roots. These bacteria are able to convert the free nitrogen present in the air spaces in the soil into chemicals known as nitrates. These nitrates are necessary to the plant, which therefore benefits by the presence of these nitrifying bacteria. In return, the bacteria which cannot make their own food obtain some of it from the plant.

We have now seen a few examples of partnership amongst animals and plants. These examples have shown how an animal or plant may benefit by the presence of another plant or animal of a different kind. There are other cases in which animals of the same kind may receive mutual benefit from partnership.

During the cold weather of winter, wolves hunt in packs for food. In a pack they are able to attack other animals, and even human beings, which they would not dare to attack alone. The food captured is shared amongst the wolves in the pack.

Zebras, deer, giraffes, and other plant-eating animals often band themselves together in huge herds, chiefly for protection. For the same reason early man formed groups of families or tribes. A number of families banded together had a better chance of obtaining food and protection than a number of separate families living alone.

The best examples of animals forming partnerships or communities in which the work is shared out are those of bees, wasps, and ants. In the beehive and wasp-nest each inhabitant has its work to do. Some bees go out searching for nectar and pollen, some take the honey and store it in the wax store cells which other bees have made,

(Harold Bastin)

Nest of common wasps built in a hole in a bank and suspended from a root

(Harold Bastin)

These Red Wood ants have built a nest out of a great mound of twigs and fir needles that they have laboriously collected

some bees look after the eggs laid by the queen bee, others feed the grubs which hatch out. Each worker-bee performs each of these tasks in turn. A newly-born worker-bee starts its life looking after the cells in the hive and keeping them clean; and after three weeks at different tasks she joins other workers in the search for pollen and nectar.

Still more marvellous are the activities of an ant community, but you should read some books on bees and ants. You will find them fascinating insects.

The ants or bees or wasps in a community are all partners, all sharing the work, and all working for the good of the community. But the finest example of animals living in a community and sharing the work and duties is that of human beings. If you just think about the work going on in a school, in an office, in a factory, in a town, in a nation, you will be able to find many cases in which one person depends on the work done by other people. As you are reading this book you are benefiting, I hope, by the work of the printer who printed the book on paper made by the paper-maker, by the work of the glass-maker who made the window, and by the furniture-maker who made the desk and seat upon which you are sitting. We depend upon the farmer and butcher for our meat, and they in turn depend on the baker for their bread. The baker depends upon the work of the men at the gas or electricity works to bake his bread, as well of course as on the work of the flour-miller, and the men who grew the wheat and the men who transported it to the flour-mill. Each of the members of a community does some work for the benefit of the community, and in return receives some benefit from the work of the other members.

WORK TO DO

1. What is the difference between *parasitism* and *symbiosis*?
2. Describe two examples of parasitism.
3. Describe two examples of symbiosis.
4. What plant is a parasite on clover?
5. Can you find out in what way (*a*) an alligator and a bird, (*b*) a sheep and a bird, are concerned in cases of symbiosis?
6. Think of any person you know and say (*a*) what work he does for the community in which he lives, (*b*) what benefit he receives from the community.
7. Name several parasites which give a great deal of trouble to man. Describe three of them and say what steps are taken to destroy them.

PROJECT WORK

1. Collect and make records of any parasitic plants and animals in your locality.
2. Write and illustrate and make a booklet about parasites.
3. With the aid of posters, specimens, models, arrange an exhibition about parasites. This may cover parasites in general, or parasites in the garden, or parasites on man.
4. Make a similar kind of booklet or exhibition about symbiosis.

CHAPTER THREE

PESTS

IF you have a school garden or your father has a garden, perhaps you may spend some time in it weeding, or spraying the plants to kill blackflies, greenflies, and caterpillars. If weeding is not done the weeds will soon be all over the garden, making it impossible for the garden plants to grow, while the caterpillars, greenflies, and blackflies are pests which may eventually kill off the plants. When you are weeding and spraying in the garden you are attempting to control the pests to prevent or reduce the damage they may do.

Man is constantly waging war against pests which attack his food crops, his animals, his stored goods, his clothes, and even himself. Some pests are just a nuisance, like the midges which bite us in summer in the country. Other pests are a serious menace to man unless steps are taken to keep them under control. The attacks of some pests may be so serious as to wipe out whole tribes and nations, or completely alter the economic life of a country, bringing about utter devastation of crops, animal life, and human life. Let us take two or three examples to illustrate this.

LOCUSTS. Most of you will know that locusts are like large grasshoppers, about three to four inches in length, and that they very often appear in huge swarms, eating whatever plants lie in their path, and doing enormous damage. One swarm, three miles wide and sixty miles long, was calculated to consist of a million million locusts. Even larger swarms have been recorded.

From very earliest times man has suffered from locust swarms. The first record of a locust is a picture on the wall of an Egyptian tomb about 2400 B.C. In 125 B.C. a vast swarm invaded the well-cultivated lands in North Africa around what we now know as Tobruk and Benghazi. This swarm completely destroyed all the crops and 800,000 people died as a result of the famine which followed. Even nearer our own times famines in China and India have often followed the destruction of crops by locusts.

(Sport and General Press Agency Ltd.)

(O. B Lean)

A good maize crop and a field of maize stripped by locusts in Argentina. Man has to fight a constant battle against pests that attack man himself, his crops, his animals, his goods, and his food

MOSQUITOES. Malaria and yellow fever are both spread by mosquitoes. Malaria is probably the most widespread of all diseases; more than one quarter of the world's population suffers from it. A tragic example of the consequences of malaria is to be seen in India. There, over one million people die every year from the disease, while many more millions suffer untold misery. Millions of people are unable to work at all, while millions more can work for only part of the year because of malaria.

Large areas of land, which could be used for agricultural or building purposes, are often left useless because they are malaria-infested. A particular example of this was the marshlands around Rome, which, until recently, were the breeding ground of the mosquitoes responsible for spreading malaria.

When the Panama Canal was being constructed, work at one time was brought to a complete standstill, because large numbers of the workers fell victims to yellow fever carried by mosquitoes. Until steps were taken to destroy the mosquitoes, the Canal could not be completed.

Nearer our own time, during the fighting in Burma and the Pacific in the Second World War (1939–45), the worst enemy the armies had to face was often not the Japanese, but the disease-carrying mosquitoes.

THE PRICKLY PEAR CACTUS. In the last two examples we have considered the damage caused by two animal pests. Plants, too, can be just as destructive to human welfare and progress. A good example is the spread of the prickly pear cactus in Australia and South Africa.

The prickly pear cactus is a native of North and South America. It gets its name from the shape of the leaves and from the sharp thorns it possesses. (You may have seen some in small pots in a florist's.) It was imported

into Australia in the first half of the nineteenth century, probably by a settler who wished to use it as an ornamental plant in his garden. Round about 1860, farmers began to use it for making hedges and as food for their cattle. From these plants large numbers of new plants grew, so that soon they spread over a vast area. By 1925 the prickly pear cactus covered an area of 60,000,000 acres of land in Queensland and New South Wales, an area more than one and half times the size of England and Wales. This land, excellent for cattle and for growing wheat, cotton, and maize, became useless and many farmers with their families were driven from their farms.

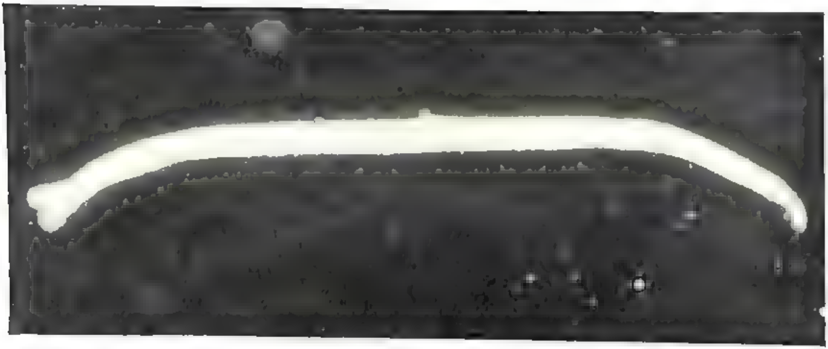
(By courtesy of the Commonwealth Prickly Pear Board)

Prickly pear had covered this land in Queensland, Australia

THE HOOKWORM. Up to the beginning of this century the people living in the rural districts of the southern states of the United States of America were widely regarded as thoroughly idle and ignorant. Their farms were neglected and unproductive, while the people themselves lived in utter poverty. People in the other states despised them, saying their poverty and low standard of living was entirely due to their shiftlessness and lack of effort or desire to improve their conditions. But then people suddenly began to show sympathy for these poor southern folk.

What changed this scorn to sympathy? It was the discovery that these rural people of the southern states were not stupid wastrels, but that they were the unfortunate victims of hookworm disease. They were people whose health, vitality, and power to work were slowly being drained out of them by a very tiny parasitic worm.

The hookworm is, when fully grown, about one quarter to half an inch in length and about as thick as cotton thread. It lives in the small intestine of a human being, fixing itself on to the delicate lining with sharp teeth, and may remain there for five or even more years. It feeds



(Douglas F. Lawson)

This hookworm lives in human intestines. The actual size of this one was $\frac{3}{4}$ inch from end to end

constantly on the blood of the victim, and moves about from one spot to another in the small intestine, so that it frequently leaves a number of very tiny bleeding wounds in its trail. While in the intestine the female hookworms produce from 5,000 to 20,000 eggs per day, and these pass out of the body in the solid waste matter, or faeces, excreted from the body. If this waste matter or faeces falls on warm moist earth, these eggs within a day hatch into hookworm larvae. These feed on the faeces and within five days are fully grown and ready to pass into a human body. If a barefooted person walks over the soil infested with these hookworm larvae, they stick on to the flesh of the foot and very soon bore their way through the skin into a lymph or blood-vessel. They are so small that the victim does not normally feel the boring. In time the larvae are carried to the small intestine, where they develop into full-grown hookworms and begin to feed on human blood.

What are the effects of this invasion of the body by hookworms? If there are not many hookworms, then a well-fed healthy person will show little effect since, from the food he eats, his body will replace the blood lost. But his body may be less able to resist attacks from other

Hookworms on wall of intestine, showing also damage done. This is a magnified view; the hookworms being very thin and under ½ inch long

(From "Chandler: Introduction to Parisitology"—John Wiley & Sons, Inc., after the International Health Board)

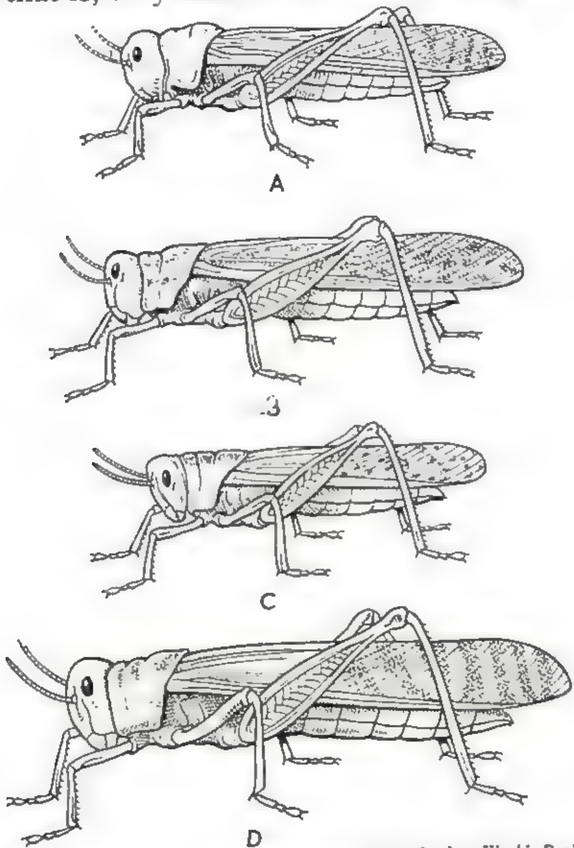
diseases, such as malaria, and he may become easily tired. If there are many hookworms in the intestine, the person will lose blood faster than his body can make it, and he will begin to suffer from anaemia. The sufferer becomes pale, lacks energy, and does not feel like work or play. You will see why, when you remember that the blood is the carrier of oxygen and food to the muscles to provide them with energy. Therefore the less blood the less energy. Often his body becomes thin, his face and abdomen become swollen. His appetite is sometimes poor, sometimes ravenous, and often he wants to eat the most unusual things, such as dirt, soil, chalk, and clay.

Now try to picture what the effect will be on a whole community, for an attack is never confined to one individual, but occurs in communities, and even in whole races and countries. The efficiency of a whole community suffering from hookworm disease will gradually be undermined, with the result that there will be a complete lowering of the standard of life. Almost anywhere in the tropical and sub-tropical regions of the world one can find the terribly unfortunate victims of hookworm disease.

It is probably true to say that the backward state of many of the peoples of tropical and sub-tropical regions of the world is largely due to hookworm disease, malaria, and malnutrition. In fact, these three form a vicious circle. The vast majority of people in the tropical and sub-tropical areas are under-nourished, and thus when they get hookworms they are unable to replace the blood lost and rapidly suffer from the worst features of the disease, which in turn reduces their resistance to possible attacks of malaria. The more ill-health, the less work can be done, and so less food is grown. Thus it is clear that before there can be any hope of raising the standard of life amongst these peoples, these three factors will have to be dealt with.

MAN AGAINST LOCUST. These are only a few of the many hundred pests against which man has a constant struggle. Let us see how he tries to keep them under control.

Until recently all methods of destroying locusts were defensive; that is, they could not be used until the swarms



(*Redrawn from Skaife: The Outdoor World, Book 6*)

The four kinds of locusts found in Africa:

A the brown locust
B the desert locust
C the migratory locust
D the red locust

were on the move. At one time people relied on charms, spells, drums, and the sacrifice of animals. In Persia people used to hang prayers on poles amongst the crops. In more recent times trenches were dug in front of advancing swarms, and as the locusts fell in they were buried, but this method required huge numbers of men to carry it out effectively. Within the last few years flame-throwers have been used to kill them. The most frequently used method now is that of scattering on the ground poison bait (sawdust, bran, and maize stalks moistened with just sufficient poisonous substances to kill locusts but not other animals such as sheep and goats). A highly successful poison called "Gammexane" has been developed which is very effective against locusts, and is practically harmless to cattle, sheep, and goats. Attempts have been made to

("*The Argus*", *Melbourne*)

Aircraft spraying "Gammexane" to clear grasshoppers from swamps in Victoria, Australia

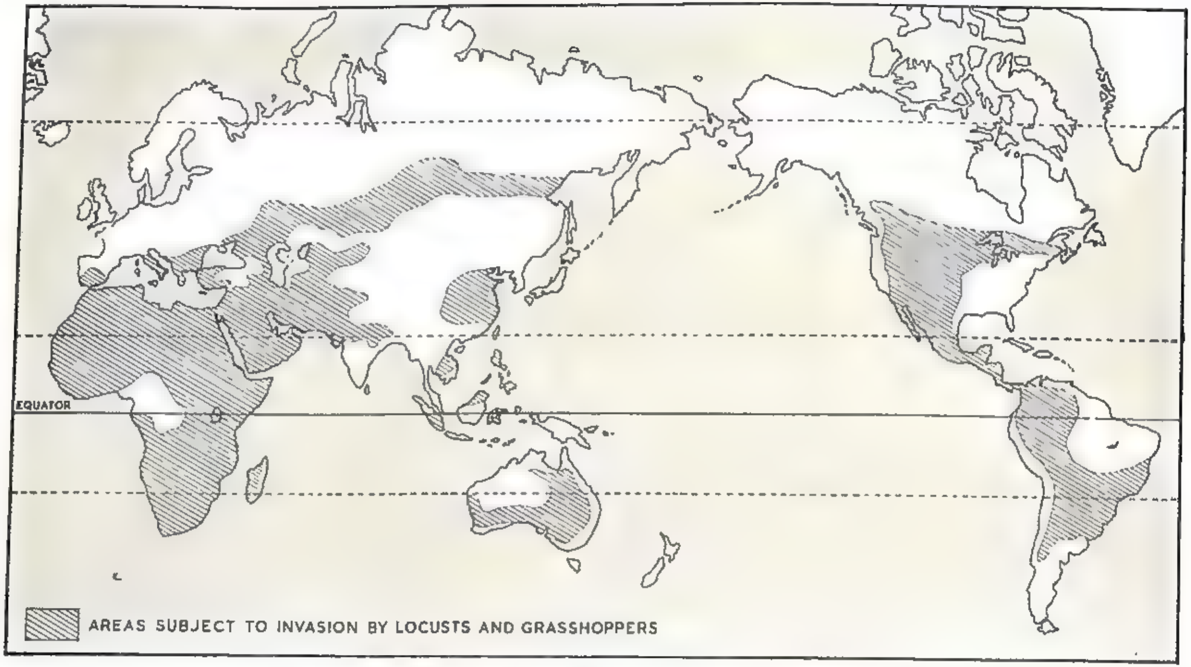
use aircraft to spray poisons on swarms on the ground or even when flying. These air attacks have not always been successful so far, but with new insecticides being developed in Britain and new ideas in using aircraft sprays, this method may prove extremely useful.

All the methods described have been defensive methods against locust attacks which are already in progress. So long as the measures were defensive only slight success would be gained, since few ever considered the more important problem of where the locust swarms came from. Clearly, if the locusts could be killed where they arose, the efforts would meet with more success.

The modern method of fighting locusts began with a discovery made about 1921 by two biologists working independently—Dr. B. P. Uvarov in London, and Professor J. C. Fauré in Pretoria, South Africa. They discovered there are two stages or phases in a locust's life—the solitary phase when the locusts behave like and actually are ordinary grasshoppers, and the gregarious or swarm stage when they become locusts and crowd together in huge swarms. But it was not then known what caused the solitary hoppers to change into swarming locusts, neither was it known where these changes took place.

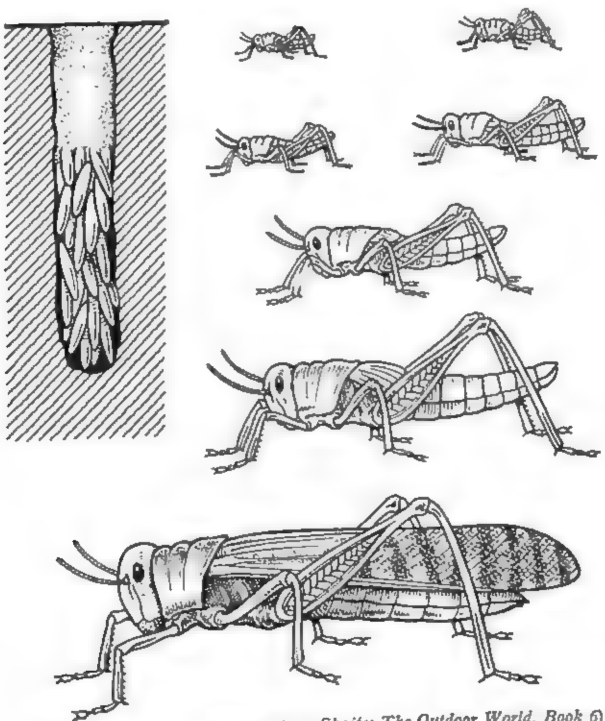
Now we know what causes them to swarm and where the swarms usually start, because in 1930 a number of nations decided to set up an Anti-Locust Research Centre. Since then scientists of all interested nations have been working together and learning all they can about locusts.

In the solitary stage, the locusts' eggs in the soil hatch into "hoppers" which are very similar to the adult locust but have no wings. The hoppers now feed greedily on plants and grow rapidly, until after a few weeks in the hot lands or a few months in the temperate lands they develop wings and become solitary locusts of a greenish colour.



(Redrawn from "The Locust Plague", by Dr. B. P. Uvarov, by permission of the Anti-Locust Research Centre)

They may live in large numbers, but there is no swarming and each lives independently of the others. But suppose that while the hoppers are living in large numbers together and feeding quite happily, a spell of dry weather sets in. The plants will begin to dry up so that soon we will have large numbers of hoppers all crowded together in any small patches where green plants may still be found. The hoppers, which hatch out from any eggs that are now



(Redrawn from Skaife: The Outdoor World, Book 6)

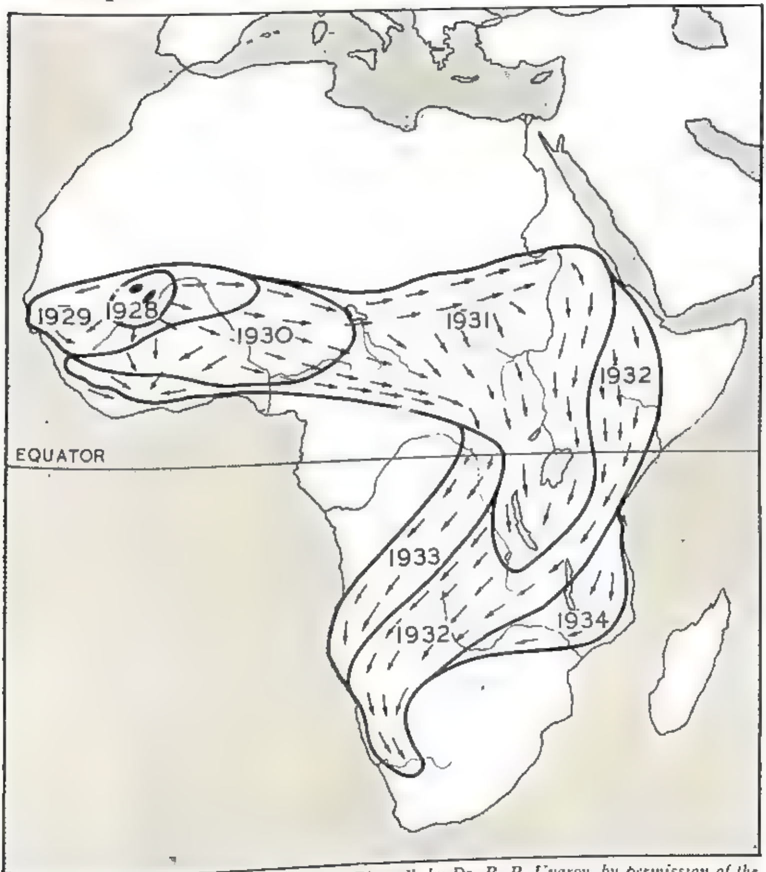
The life history of the red locust. At the top on the left is a packet of eggs laid in a hole made two or three inches into the soil. In which drawings is the insect still a hopper? When and where does it grow wings?

laid, are darker in colour than the solitary type; and from these hoppers develop locusts which are black and yellow in colour and much more active than the solitary locusts. What is more, they now begin to swarm in huge masses consisting of millions of gregarious or swarming locusts. The swarm may fly for several hours and often cover distances of several hundred miles. When they land they very quickly eat up the leaves of all crops, grass, and trees roundabout. Any eggs that are laid will hatch into hoppers, and these will begin to swarm in millions over the countryside, eating all plant life before them. (The direction of the flight of the swarming locusts seems to depend largely on the strength and direction of the wind, while that of the hopper swarms seems to be influenced, not by where food is most plentiful, but by certain weather conditions.)

As scientists in various parts of the world studied locusts and sent in regular reports to the Anti-Locust Research Centre in London, it became clear that swarms seemed always to start from a few definite areas in the world known as "outbreak areas". For example, the Red Sea area and Arabia are now known to be outbreak areas for locusts which cause destruction in Northern Africa, the Middle East, and India. Argentina is the outbreak area for locusts which swarm all over Argentina, Uruguay, Brazil, and other South American countries.

This discovery led to the modern methods of fighting the locust menace. In the outbreak areas permanent observers have been appointed, whose duty it is to watch for and destroy any gathering of solitary locusts before they turn into locust swarms. These permanent observers, and others in lands which suffer from invasion of locusts, send in regular reports to the Anti-Locust Research Centre. From these it is possible to say what is likely to happen, so that if a swarm does break out, steps may be taken to

combat it and lessen the damage which may result. Regular international conferences are held, for it is only by the united efforts of all nations concerned that we can ever hope to win the battle against locusts.



(Redrawn from "The Locust Plague", by Dr. B. P. Uvarov, by permission of the Anti-Locust Research Centre)

One locust outbreak harassed half Africa. Locusts swarmed in 1928 in the areas shown in the two black patches. Each of the rings shows the area invaded in the following years by these locusts and their progeny

The battle is not yet won, and whether we shall win it completely we do not know, but these modern methods of fighting the locust, resulting from the discoveries of scientists, are meeting with much success.

MAN AGAINST MOSQUITOES. Towards the end of the nineteenth century scientists began to study the two destructive diseases, malaria and yellow fever. A French scientist, Alphonse Laveran, in 1880, was the first to show that malaria was caused by a small organism, but nothing was known about how it got into the body. Some years later an Englishman, Dr. Patrick Manson, suggested that perhaps mosquitoes carried these malaria organisms. After much experimental work, Ronald Ross, another Englishman, in 1897, proved that certain kinds of mosquitoes (*Anopheles*) were responsible for carrying the malaria organism. The discovery was made independently at the same time by an Italian doctor, Battista Grassi.

How does a person get malaria? Mosquitoes feed by sucking blood. Very likely an *Anopheles* mosquito has been sucking the blood of a person suffering from malaria. This blood will contain the organisms causing malaria. The mosquito will now have in it malaria organisms, and these develop and pass in large numbers to the salivary glands of the mosquito. Now perhaps the mosquito flies on to a healthy person and begins to feed on his blood. First the mosquito pierces through the skin with its mouth-parts. It now sends out saliva from its salivary glands into the tiny wound to prevent the blood from clotting, and begins to suck up the blood.

But the mosquito's saliva has now got in it the organisms that cause malaria and in this way the mosquito passes on the disease from one victim to another. The organisms make their way into the red blood cells and there increase

in large numbers. Every three or four days these burst out of the red blood cells into the blood stream and invade and destroy more red blood cells. At the same time poisons from the organisms pass into the blood stream, causing a rise in temperature. Thus a victim of malaria suffers from an extremely weakening fever which occurs every three or four days.

(By courtesy of United States Information Service)

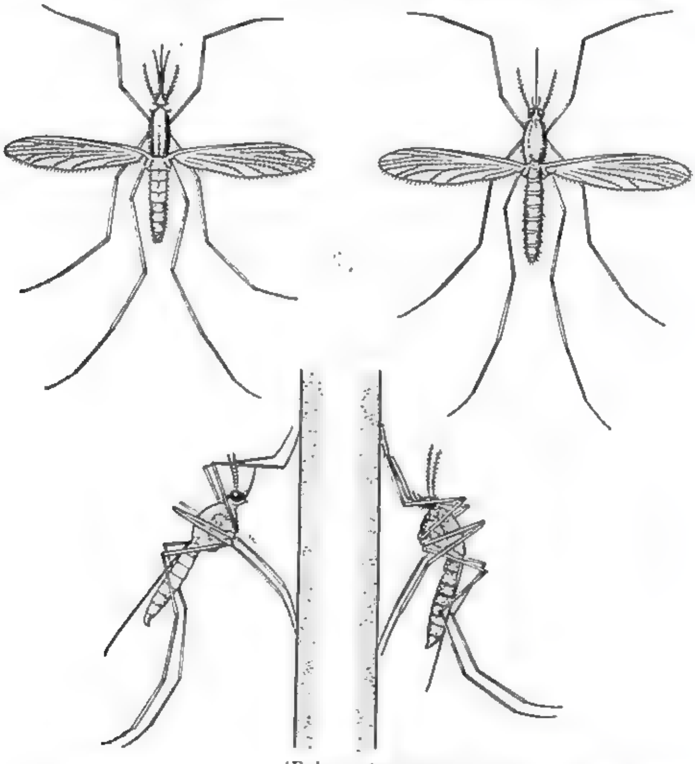
Walter Reed, American army surgeon

Yellow fever, which occurs mostly in tropical and sub-tropical lands, was found to be spread in a similar way by another type of mosquito. A very daring and heroic group of Americans proved this. A small group of men led by Dr. Walter Reed volunteered to live in two wooden huts built in a swampy district which was infested with yellow fever. Each of the two huts was screened so that no mosquitoes could enter, and great precautions were taken to see that none of the men were bitten or had been bitten by mosquitoes.

One of the huts was badly ventilated and made hot inside. For twenty nights a number of men lived in the hut wearing the pyjamas and using the bedding of men who had died of yellow fever. Everything was intentionally done to infect them with yellow fever, but they did not contract it.

In the second hut the conditions were perfect; the hut cool and well ventilated and the men who lived in

it were given clean sterilised clothing and bedding. They, too, remained quite healthy. Then the second hut was divided in two. Part was screened off so that no mosquitoes could get in; the other part was left unscreened and mosquitoes that had bitten yellow fever victims were introduced into it. The men in the first part stayed healthy, those in the second went down with yellow fever. Finally some of the men from the first hut came to live in the second hut; they were also bitten by

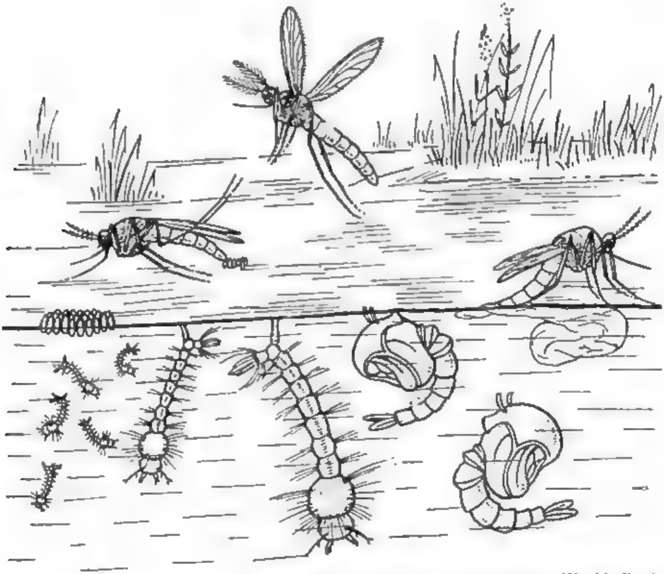


(Redrawn from Skaife: The Outdoor World, Book 4)

Adult mosquitoes: males above, females below.
Those on the left carry malaria, those on the right do not

the mosquitoes and caught yellow fever. Thus it was proved that yellow fever was carried by mosquitoes. As a result of the experiment some of the gallant volunteers died, but their sacrifice led to the saving of millions of lives.

Before the discovery that mosquitoes carry the malaria and yellow fever organisms, nothing could be done to prevent people catching these diseases. Now it was possible to take steps to control and destroy mosquitoes. Suitable screens and netting in rooms and sleeping quarters prevent mosquitoes getting to a person. Chemicals known as repellents can be applied to the skin and clothing to keep mosquitoes away.



(Redrawn from Skaife: The Outdoor World, Book 4)

The life history of a mosquito. At the top is a fully grown male. Find each of these stages: (*a*) eggs floating on water, (*b*) young larvae, (*c*) larger larvae, (*d*) pupae, (*e*) adult emerging from pupa, (*f*) female laying eggs

The best method of control, however, is the widespread destruction of mosquitoes. Fortunately this can be done. Look at the illustration showing the stages in the life of a mosquito. The egg, larva, and pupa stages are spent in water. So methods of control include:

1. The drainage, where possible, of marshlands and pools.
2. Spraying with oil the surfaces of water where mosquitoes breed, to prevent their laying eggs and to make it impossible for larvae and pupae to breathe.
3. The covering of all tubs, barrels, and other water-containers where mosquitoes might lay eggs. People living in malarial districts are warned not to leave empty tins lying about, as even these may collect water and provide breeding places for mosquitoes.
4. Spraying poisons in breeding areas.
5. Introducing fish into pools and lakes, to live on the larvae and pupae.

(By courtesy of United States Information Service)

This aeroplane is dusting marshes in the Tennessee Valley with poison, during the mosquito-breeding season

6. Training and education in simple ways of preventing mosquitoes breeding. This is very important, since without the co-operation of the people in mosquito-ridden areas, the fight against malaria cannot be wholly successful.

The latest weapons which have been used successfully in the destruction of mosquitoes are two chemicals—DDT and Gammexane. Both these insecticides can be sprayed inside houses and tents or on the surface of pools or large stretches of water where mosquitoes breed.

In this fight against malaria and yellow fever, we see how the combined efforts are needed of doctors and biologists (who discovered the part played by mosquitoes

Areas infested with Prickly Pear

in spreading these diseases), chemists (who discovered insecticides and repellents), engineers (who invent machines to spread the insecticides), and of educationists (who teach people how to fight malaria and yellow fever).

MAN AGAINST THE PRICKLY PEAR CACTUS. In early years, the fight against the prickly pear cactus in Australia seemed hopeless. Ploughing in the plants and the use of poisons both failed. However, scientists were sent over to America to see if they could find in the country, where cacti grow naturally, any insects that attack prickly pear cactus. After many experiments they found two

Can you see where egg-sticks of Cactoblastis have been pinned on leaves of the prickly pear cactus?

insects which fed only on the prickly pear cactus. The *Cactoblastis cactorum* or moth borer, found in the Argentine, is a small greyish moth which lays its eggs on the prickly pear leaf. The caterpillars which hatch out bore into the leaves, and eventually kill the cactus.

In 1925, the first moth borers were sent to Australia and at specially built breeding stations scientists carefully reared these and from their eggs grew more and more of them. These were released in large quantities in the infested areas. The moth lays its eggs in little sticks of about seventy. These are gently glued on to small sheets of paper or packed into wax-paper tubes, which are then pinned on to the leaves of the cacti.

At the same time scientists distributed slices or pads of prickly pear leaf infested with the other insect that eats

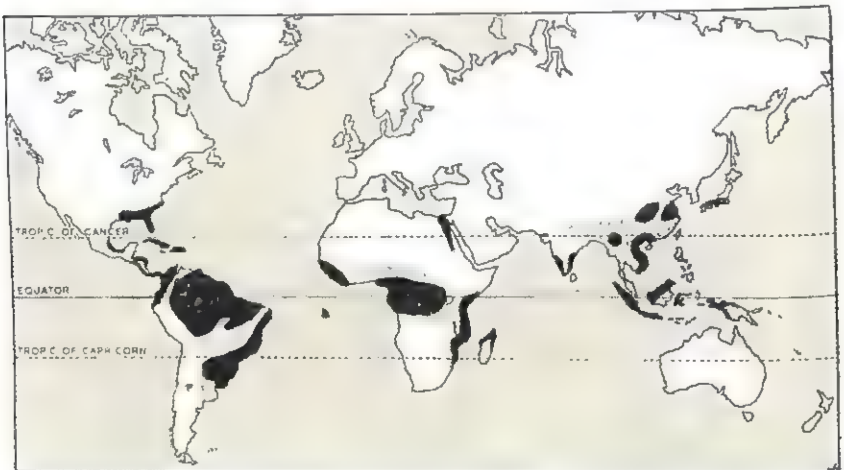
(By courtesy of the Commonwealth Prickly Pear Board)

This is the same area as in the photograph on page 35—two and a half years later

the prickly pear cactus, the cochineal insect. It was found that this insect was especially useful for clearing very dense growths of the pest.

The result was successful. The moth borer caterpillars hatching out of the eggs and the cochineal insects soon began eating away the prickly pears, so that by 1932 about 90 per cent of the prickly pear had been wiped out.

But now there was a set-back. The Moth Borers and the cochineal insects were losing the only kind of food they eat. Thus, when the prickly pears were nearly destroyed, the moth borers and the cochineal insects themselves began to die out rapidly. At once the prickly pear began to increase. At first farmers and scientists were worried about this, but they found that as the prickly pear increased, so once more did the numbers of the moth



(Redrawn from "Chandler: Introduction to Parasitology", by permission of John Wiley & Sons, Inc.)

Map showing the distribution of hookworm infections. Solid black parts show where the infection is heavy; stippled areas are where infections are light, but in a high percentage of individuals

borer and the cochineal insect, and the destruction of the prickly pear began again. Now the menace of the prickly pear cactus has been removed, and large areas of land are once again being used for farming.

The story of the battle against the prickly pear in South Africa is much the same. The moth borer and the cochineal insect were introduced there from Australia in 1932, and in spite of some difficulties not found in Australia are keeping the prickly pear cactus under control.

MAN AGAINST THE HOOKWORM. We have already seen the deadly danger resulting from hookworm disease. How can we deal with it? How is the battle fought against it?

The battle began in 1838 when an Italian scientist, Dubini, discovered the hookworm. The next step came forty years later when it was proved that the epidemic of anaemia among the labourers at work on the St. Gotthard Tunnel in Switzerland was caused by hookworms.

Biologists then set to work to discover all they could about hookworms. When the life-story of the hookworm was discovered, it soon became clear that the infection was spread by barefooted people walking over soil which had been infected by human faeces containing hookworm eggs. In primitive communities there are no lavatories or privies. Even in the southern states of the U.S.A., at the beginning of this century, 68 per cent of the homes in the country had no privies, while amongst those which did have them, the privies were often unsuitable.

With this knowledge behind them, health authorities began to tackle the problem by:

1. Making medical treatment available to the people living in a hookworm-infested area.
2. Encouraging people, especially children, to wear sandals, shoes, or boots.

3. Disinfecting soil, and preventing soil pollution. Though this is the most effective method to use in the fight against the hookworm pest, it is not easy to put into practice. Through many generations over hundreds of years, these people have performed their daily habits in certain set ways, and it is very difficult to get them to replace these well-established habits by more hygienic ones.

The most important weapon in the battle against hookworm disease is education. Only by patiently and slowly educating people into hygienic ways of excreting waste can we hope to clear the world of hookworm disease.

So the fight goes on. There is no relenting in the battle against pests which spread trouble and disease; there can be no rest in the struggle. Foremost in the struggle are the scientists who discover new weapons to use. But in the fight also is the ordinary citizen; you, yourself, who must take whatever steps and precautions that are necessary to defeat the pests and to keep healthy.

(Harold Bastin)

(Vi a Elka

House fly

Rat

In what way is each a dangerous pest?

WORK TO DO

1. Name four pests commonly found in the garden and the steps taken to control them.
2. Name any pests found in your school garden and describe steps taken to prevent or control their attacks.
3. Look up in biology books or gardening books some plant or animal diseases and find what steps are taken to control them.
4. In this chapter you have learned something of the methods used to control some of the most destructive pests in the world. Make a study of some of the following pests, the damage they do, and methods of control used: *tsetse fly*, *rats*, *warble fly*, *Colorado beetle*.
5. Write an essay to show that "Man's progress is often hindered by the attacks of pests".
6. How has the scientist contributed to the welfare and happiness of mankind in the fight against pests?
7. Some of the accounts of the battles against various pests, and the people who did much to win the fight, make very interesting reading. Look in your local library or school library for books about Sir Ronald Ross and the mosquito, and about Dr. Walter Reed and yellow fever.
8. It is often considered that people living in the temperate zones have made greater progress than those living in the tropical and subtropical zones. Do you think that such pests as mosquitoes, tsetse fly, locusts, and hookworm have had anything to do with this? Give reasons, of course, for your answer.
9. Up to the seventeenth century plagues often occurred in England. Find how these were caused, what the plagues were, and say why we have no plagues now.
10. What steps must be taken in some countries before the standard of life of the people can be raised?
11. In the fight against the prickly pear cactus in Australia and South Africa, insects were introduced as a control. Find out other ways in which insects have been specially reared to control some pests.
12. What precautions have to be taken in making use of insects in the control of pests?

PROJECT WORK

1. *Control of Pests in the Garden.*

   a. Make a collection of pests from the garden with examples of the damage done.

   b. Make posters to illustrate the life-history of pests and the harm they do.

   c. Make posters to illustrate methods of control, with an exhibition of samples of materials used, graphs and figures from actual work in the garden.

2. *Control of Pests of Social Significance.*

   e.g. hookworm, mosquito, locust, prickly pear, tsetse fly.

   a. Make posters and specimens of each pest and its life-history.

   b. Make posters and maps to show damage done or disease caused, where it occurs, and effect on the life of people.

   c. Make posters, models, specimens to illustrate methods of control.

   d. Make posters showing results of control.

3. *Control of Pests in the Home.*

   e.g. rats, mice, cockroaches, crickets, fleas, bugs, dry rot, etc.

   Make for each pest an exhibition with posters to show the dangers arising from each pest and the ways of getting rid of the pests.

4. What else can you find out about the *biological control* of pests, of which the control of prickly pear is an example?

(*Harold Bastin*)

Tsetse fly

(*Harold Bastin*)

Colorado beetle

In what way is each a dangerous pest?

CHAPTER FOUR

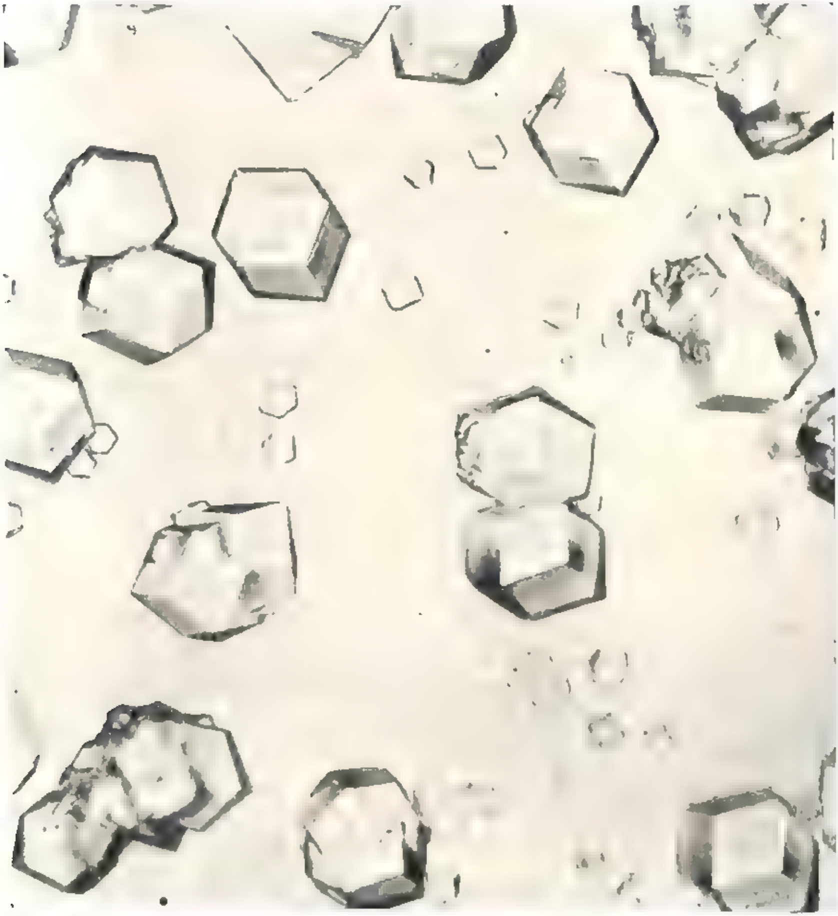
BACTERIA AND THEIR WORK

AS we have gone along in our study of living things we have frequently talked about germs and microbes. Usually these words call up in our imaginations the most weird and wonderful creatures. Most people imagine them to be horrid creepy-crawly things with thousands of legs. But if they were to see some under a microscope they would probably be very disappointed. By the words "germs" and "microbes" we refer to *micro-organisms*; the smallest of living things known to us. The largest are visible only under a very powerful microscope. Some, indeed, are so small that they are not even visible under the electron microscope which magnifies 100,000 times. We divide these micro-organisms into three groups—viruses, bacteria, and protozoa.

VIRUSES. Viruses are responsible for many diseases of living things, including influenza, the common cold, yellow fever, infantile paralysis, measles, mumps, rabies in dogs, foot-and-mouth disease in cattle, mosaic disease in tomatoes and tobacco plants, swollen shoot disease in cocoa trees.

It is very difficult to say what viruses are, since they are so small, from about 1/10,000 of a millimetre to 1/50,000 of a millimetre in diameter. It is only recently that they have been made visible by the extremely powerful electron microscope. Some have a threadlike appearance, while others are spherical. They appear to be on the borderline between living and non-living things. As far as is known

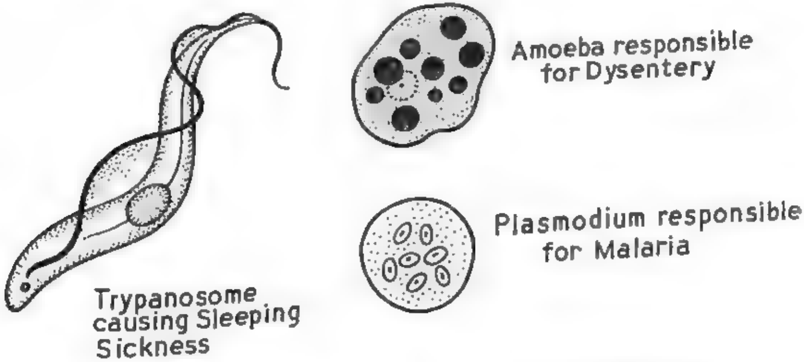
at present, viruses only live and reproduce as long as they are in living material upon which they are parasitic.



(By courtesy of Rothamsted Experimental Station)

This is a photograph of the crystals of the Tomato Bushy Stunt virus. The magnification is $\times 350$

PROTOZOA. Some micro-organisms are single-celled animals and are called protozoa. They are much larger than viruses, but still only visible under a very powerful microscope. When examined thus, they are seen to have a nucleus. Some of these protozoa are responsible for quite a number of diseases—dysentery, malaria, and sleeping sickness. Usually they are transmitted to a human being by some insect. For example, the mosquito transmits the protozoa which cause malaria, and the tsetse fly carries the protozoa which cause sleeping sickness.



Protozoa (all highly magnified) causing disease in man

BACTERIA. The third group of micro-organisms are the smallest known plants and are called bacteria. It is to these that we shall give the rest of our attention in this chapter.

Bacteria are amongst the smallest of living things. The largest is only one-hundredth of a millimetre long.

Although biologists have discovered many different kinds of bacteria, we can usually divide them into four types.

Some are shaped like tiny balls or spheres. These are known as *cocci*. Some cocci always appear in long chains, and these we call *streptococci*. They cause sore throat, tonsilitis, and scarlet fever. Other cocci always appear bunched together and are known as *staphylococci*. These cause boils, carbuncles, abscesses, and blood-poisoning.

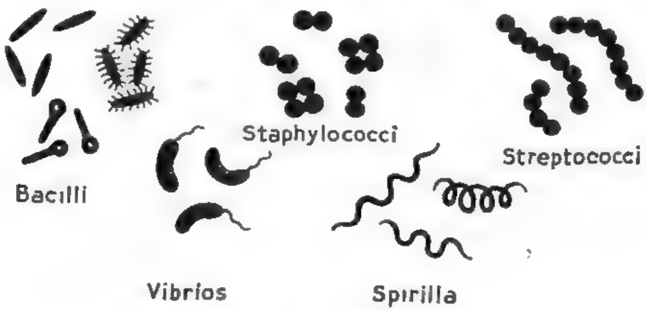
Some bacteria are oblong or rod-like in shape, and these are known as *bacilli*. Typhoid, diphtheria, anthrax, and tuberculosis are caused by bacilli.

Bacteria in the shape of curved rods are called *vibrios*. Cholera is caused by such bacteria.

The fourth group of bacteria are spiral-shaped, and so are called *spirilla* or *spirochaetes*.

When seen under the microscope, cocci do not seem to be able to move; they float about in whatever fluid they are. Similarly, some of the bacilli are incapable of movement, but other bacilli and all the vibrios have fine hairs called *cilia* which lash about and thus cause them to move. The spirochaetes are quite active and swim by a kind of corkscrew or twisting movement.

Bacteria, like other living things, must have food to build up their protoplasm and to provide energy for their



Bacteria causing disease in man

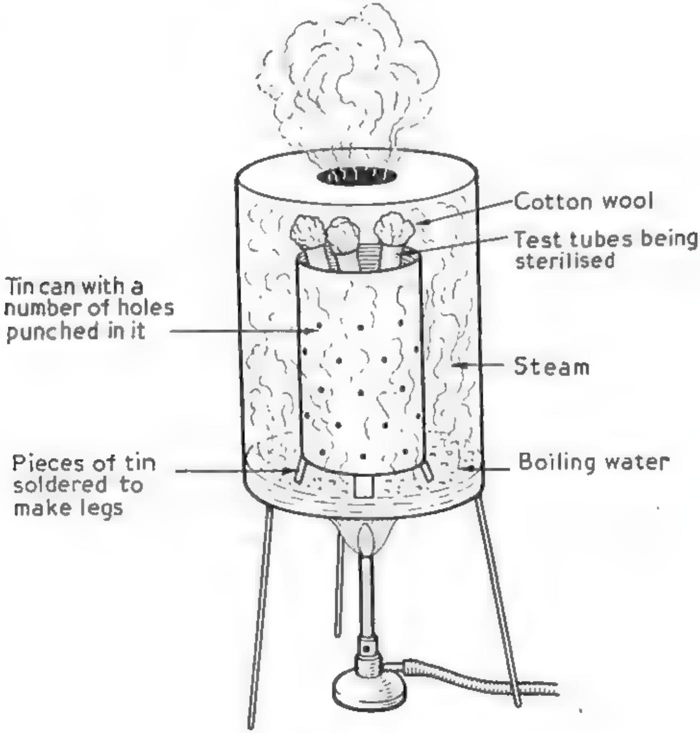
few activities. Almost anything seems to provide them with their food—jam, milk, bread, water; even soil, leather, the air, and chemicals. For this reason bacteria can be found almost anywhere. Large numbers get into our bodies and into the bodies of animals through the air breathed in and the food eaten, and live there.

Like the amoeba, bacteria increase in numbers by dividing into two. If the bacteria can get enough food and moisture, and are at a suitable temperature, they divide almost every twenty or thirty minutes. Thus, in thirty minutes one bacterium becomes two. In an hour these two become four. In another half-hour these four become eight, and if this rate of increase is kept up, in thirty-six hours one bacterium would have led to the formation of about 9,500,000,000,000,000,000 or 9,500 million million million bacteria! This rate of reproduction, however, is not maintained, but is reduced by changes in conditions, such as lack of food and moisture, by poisonous substances produced during their life, and by changes in temperature.

Bacteria are able to withstand to some extent changes in temperature or in their environment. When the conditions under which a bacterium is living become unsuitable it may die or it may develop a protective wall round itself and go into a *spore* or resting stage. In this spore stage the bacterium is able to survive and withstand great heat, severe cold, or even prolonged lack of food. Even milk or water after boiling, and meat after freezing, are still found to contain bacteria.

Bacteria play such an important part in our life that many biologists are engaged entirely in the study of bacteria. This study of bacteria is known as bacteriology. We also can be bacteriologists, but to perform experiments on bacteria we shall have to prepare in a special way the apparatus we are going to use.

We have already seen that bacteria can occur almost everywhere, and there are certain to be some on the apparatus we use. If then we wish to study some particular bacteria from some particular substance, we must first see that the bacteria on our apparatus are destroyed. When we kill the bacteria on the apparatus we say it is *sterilised*. Usually the test-tubes and vessels to be used are sterilised by steam or hot air.



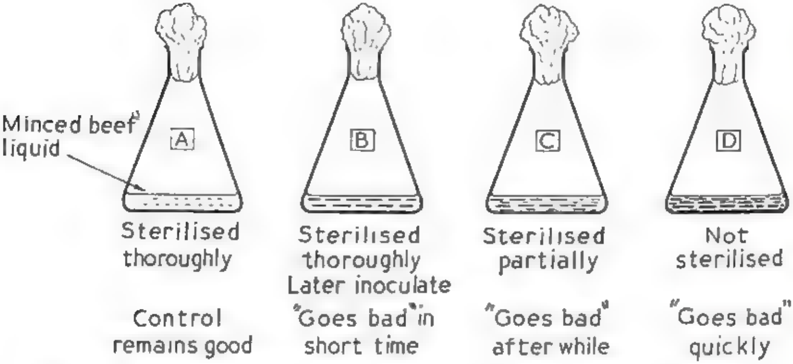
A steam steriliser

For your experiments you will need a few small flasks, test-tubes, some flat dishes called Petri dishes, and some cotton wool. Into each of the test-tubes and flasks put a tight wad of cotton wool. If you have a hot-air oven in the school laboratory, then you can sterilise the flasks and Petri dishes in the oven. For the test-tubes you can easily make a steam steriliser out of two tin cans. If you look at the sketch you will see how this is done.

To sterilise the apparatus place it in the oven or steam steriliser for about three-quarters of an hour on *each* of three successive days. After the first heating most of the bacteria will be killed, but some of the bacteria may be in the resistant spore stage. On the second day most of these will be in the ordinary bacteria stage and so will be killed by the second day's heating. After the third day's heating the apparatus should now be sterilised.

When we make special experiments to grow or cultivate bacteria we are said to be making *cultures* of bacteria. Bacteria, of course, require food, and therefore we must prepare food for our bacteria cultures. In a beaker place 100 c.c. of water and heat it. To this add 1·0 gram of peptone, 0·5 gram of common salt, 1·5 grams of powdered agar-agar, and 1·0 gram of Bovril or Oxo or beef gravy. Keep stirring the mixture and heat until the agar-agar is dissolved. (Peptone and agar-agar can be obtained from the chemist. You may use gelatine instead of agar-agar.) To the mixture must be added sufficient bicarbonate of soda to make a piece of red litmus paper turn blue when dipped into the mixture. Now you must place some cotton wool or a filter paper in a funnel and filter the hot liquid into a clean beaker. This process must be done in a warm oven or in the steam steriliser, for otherwise the mixture will set solid in the funnel. Now fill several test-tubes one-third full with the mixture. Make a tight plug of cotton wool for each test-tube, set one end of it alight and quickly plunge the burning end into the test-tube. The burning will cease, the cotton wool plug will be sterilised, and will close up the test-tube. These test-tubes must now be sterilised as already explained.

To show the effect of sterilisation. Put 2 ounces of minced beef into 100 c.c. of water in a beaker for several hours. Filter off the clear liquid and put an equal amount in each of four small flasks labelled A, B, C, and D. Plug each flask with sterilised cotton wool. Sterilise flasks A and B for three-quarters of an hour on each of three days. Heat flask C for one three-quarters of an hour only. Flask D is not heated at all. Leave these to stand, and observe over a period of several

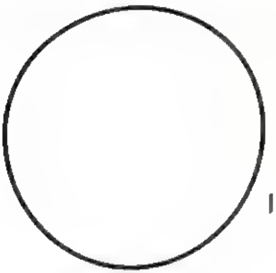


days. Very soon the liquid in flask D which was not sterilised will go bad. More slowly the liquid in flask C will go bad, but that in flasks A and B will remain clear and show no signs of going bad because they have been properly sterilised. If now the plug of cotton wool from flask B is removed for several hours and then replaced, it will soon begin to go bad. Why is this? It is because there are floating about in the air certain bacteria which cause things to go bad or putrefy; some of these fall into the flask and cause the fluid to go bad.

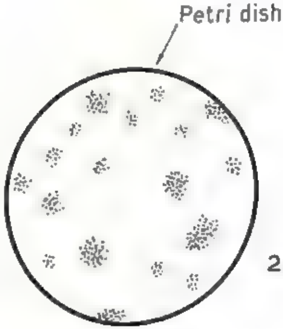
Experiment to make cultures of bacteria from the air. Take two Petri dishes and sterilise them completely. Take two of the sterilised test-tubes of culture food or medium and warm them in a hot-water bath until the medium has melted. Warm the open end of one of the test-tubes to kill any bacteria which may be on the outside. Now, as quickly as possible, pull the cotton wool plug out of the test-tube, lift the lid of one of the Petri dishes just a little, and pour in the melted sterilised medium. All this must be done carefully to avoid letting bacteria into the dish. Always when pouring culture medium, fluids, or other substances into a sterilised Petri dish, do it in this way to avoid entry of any unwanted bacteria into the Petri dish. Do the same with the second Petri dish. We now have two sterilised Petri dishes containing sterilised culture medium. When the medium has set solid remove the lid from the second Petri dish in a room. After five minutes replace the lid and place both Petri dishes in a warm dark place or cupboard. This will encourage any bacteria which may be in the dishes to multiply.

Test tube of culture medium (sterilised)

Pouring melted culture medium into sterilised petri dish



Control remains clear



Exposed to air colonies of bacteria form

At the end of two days examine the Petri dishes. The culture medium in the first dish should be clear because it was sterilised and contained no bacteria. In the second Petri dish the medium will be covered with a number of dots or circles. Each of these dots or circles is a colony of millions of bacteria. Each colony has grown from a bacterium which must have fallen into the medium from the air of the room when the lid was taken off. Note the number, size, and colour of the colonies of bacteria. Sometimes a fluffy colony or two forms. This is a mould which has grown from a mould spore which fell in. The first Petri dish we call a control because it is used to show whether the experiment was done properly with the dishes completely sterilised.

In the same way you should prepare cultures of bacteria from the air of a crowded room, from an empty room, from a room just before dusting, from the same room during the dusting and immediately after dusting. You should also make cultures of the bacteria from the air of a room when it is being cleaned with a duster and brush and when it is being cleaned with a vacuum cleaner. You could, too, make cultures from the air out in the school yard. Compare the colonies in each case, note carefully any differences, and write out any observations you make.

To prepare cultures of bacteria from milk and other liquids. Boil some distilled water and pour 10 c.c. into each of five sterilised test-tubes, using a sterilised pipette to do so. Plug each test-tube immediately with sterilised cotton wool. Using sterilised pipettes, measure out 1 c.c. of fresh milk into the first test-tube with one pipette, 1 c.c. of milk after standing six hours into the second with another pipette, 1 c.c. of milk after standing a day into the third, and 1 c.c. of pasteurised milk into the fourth. A clean sterilised pipette must be used each time. Plug the test-tubes again immediately and revolve the test-tubes between the hands to get contents well mixed.

Now place five prepared test-tubes containing culture medium into a warm-water bath just sufficient to melt the medium. Using fresh sterilised pipettes, introduce 1 c.c. of the fresh milk solution into the first test-tube, 1 c.c. of the six-hour milk into the second, 1 c.c. of the day-old milk into the third, and 1 c.c. of the pasteurised milk solution into the fourth. Keeping the test-tubes just sufficiently warm to melt the jelly, revolve them between the hands. Now pour each of the inoculated media into a separate sterilised Petri dish and the medium from the fifth test-tube (to which you added nothing) into a fifth Petri dish. Leave the Petri dishes to stand in a warm dark cupboard for two or three days and then examine them.

Note carefully any differences and write out in your note-books a full record of your observations.

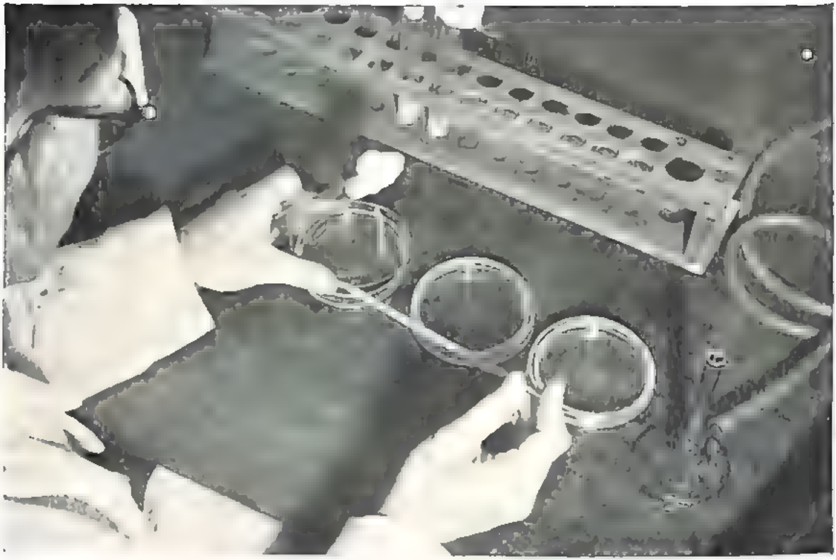
To prepare cultures of bacteria from the hand. Warm the culture medium in three sterilised test-tubes and pour into each of three sterilised Petri dishes. When the media have set, raise the lid of the first slightly and gently draw your fingers over the medium. Now wash your hands well in hot water and soap, and then raise the lid of the second dish and gently draw your clean fingers over the medium. The third dish is to act as a control. Place the three dishes in a warm dark cupboard for two or three days. At the end of this time observe the media carefully and describe exactly what you see.

USEFUL BACTERIA. When people hear the words germs, microbes, or bacteria, almost immediately they think of the diseases they cause. They associate bacteria with disease. Bacteria, indeed, are the cause of many of the diseases from which human beings, animals, and plants suffer, but not all bacteria are harmful. Some are very useful, and without the help of certain kinds of bacteria, life for man, animals, and plants on this world would be impossible. Certain industries also depend upon bacterial action. Let us study briefly a few examples of useful bacteria.

If food is left lying about it will almost certainly begin to go bad and finally rot. Most rotting and decaying are due to the action of bacteria, and we usually consider it a hindrance. When a plant or animal dies millions of bacteria soon begin to inhabit the remains. They break down the complex chemicals of the dead plant or animal into simpler chemicals. This process we call rotting. In this case it is very useful. The simple chemicals formed during the decaying process pass into the soil and become food for plants. Thus the remains of the dead plants and animals are cleared off the land and turned to useful material by bacteria.

The various tastes in butter and cheese are due to different kinds of bacteria which are present in the milk from which they are made. Certain cheeses and butter are inoculated with special bacteria to give the cheeses and butter their special flavours. Very often the milk used is completely sterilised and then inoculated with cultures of these special bacteria. These cultures are prepared in test-tubes in laboratories and sent out to the dairies.

The sour milk used in making cheese is turned sour by bacteria. The best vinegar is made from wine which is soured by the action of bacteria. In the preparation of



(By courtesy of the National Institute for Research in Dairying)

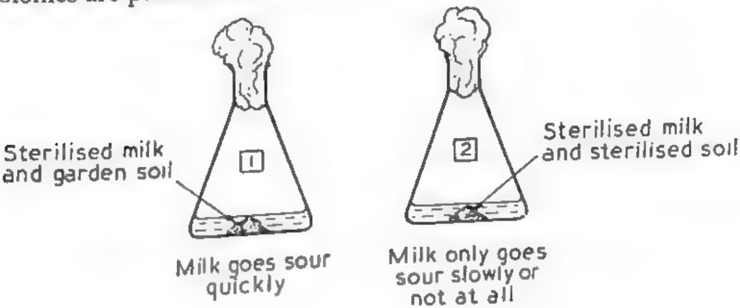
Making cultures of bacteria for use in making cheese

leather from the hides of animals some of the processes depend upon bacterial action. The purification of sewage and its conversion into fertiliser depends upon the action of certain kinds of bacteria. Thus the bacteria turn dangerous waste into useful materials.

Not only are bacteria useful in industry and in breaking down the dead bodies of animals and plants, but certain animals, especially grazing animals, depend upon bacteria for help in digesting their food. Plant cell walls are built up of cellulose and cellulose is difficult to digest. Living in some part of the alimentary canal of most grazing animals are bacteria which are able to break up cellulose and convert it into glucose. This glucose can then be used by the animal for food.

BACTERIA IN SOIL. By performing the following experiments we can prove that there are bacteria living in soil.

Experiment 1. Shake 1 gram of soil with 100 c.c. of distilled water in a sterilised flask. Allow to stand and then, using a sterilised pipette, transfer one or two drops of the soil water to a prepared test-tube in which the culture medium has just been warmed sufficiently to melt the medium. Revolve the test-tube between the hands, pour the contents into a sterilised Petri dish, and leave the dish in a warm dark place for two days. On examination you should note if any bacteria colonies are present and what they are like.



Experiment 2. Pour some milk to the depth of an inch into each of two flasks. Plug the flasks with cotton wool, and sterilise the flasks and contents. Into the first flask introduce some garden soil. Into the second flask introduce some soil which has been sterilised by heating on three successive days for about an hour. Leave the flasks to stand in a warm dark place for a day or two. At the end of this time you will find the milk in the first flask will have turned sour, while the milk in the second flask has not turned sour or is only just turning sour. Milk, we have seen, is soured by bacteria, and therefore we conclude that the garden soil must contain bacteria.

The bacteria in the soil are of great importance, for plants depend upon the work of bacteria to get their food. Some of the soil bacteria cause dead plants and animals to decay. The decomposed remains form humus. From this humus plants obtain most of the minerals they require.

Other kinds of soil bacteria decompose manure and form nitrates and other plant food from it. Certain bacteria in the presence of lime are able to change an acid or sour soil into a good growing soil. In Chapter Two we mentioned that tiny swellings can be seen on the roots of peas, beans, and lupins. These are the homes of useful soil bacteria which can change free nitrogen into nitrates. We call these *nitrogen-fixing bacteria*.

There are in the soil some bacteria which are harmful. For example, in very damp or waterlogged soil there live certain types of bacteria which break down the nitrates in the soil and change them into chemicals which the plant cannot use. These are called *denitrifying bacteria*.

(H. Nicol)

Nitrogen-fixing bacteria have made the nodules on the root of this healthy soya bean plant

Soil bacteria play an important part in making certain artificial fertilisers available for plants to use, and also in the rotting of the material in the gardener's compost heap. One of the artificial fertilisers most frequently used to supply nitrogen to plants is sulphate of ammonia. This is scattered very finely on the soil, but as long as it remains sulphate of ammonia, plants cannot make use of it. Fortunately, in the soil there are bacteria which change it into nitrate, which plants can then use as a source of nitrogen. That is why sulphate of

ammonia is sometimes called a slow-acting fertiliser, since, before plants can use it, bacteria have to convert it into nitrate. On the other hand, nitrate of soda, which is often used as a fertiliser, is quick-acting, because it is at once available for use by plants.

When gardeners have pulled their peas, potatoes, and other plants, they frequently make a compost heap of the stems and leaves. They spread these out into a nine-inch layer, about five feet by four feet. On this they sprinkle some sulphate of ammonia and then a one- or two-inch layer of soil. This is repeated until the heap is about three feet in depth. Then it is left with a three- or four-inch layer of soil at the top. In the heap there will be millions of bacteria, and with the provision of sulphate of ammonia as nourishment for them, they will thrive and develop enormously in numbers. These hordes of active bacteria then cause the plant remains in the heap to decay into a black mass called humus, which is excellent for spreading on the garden and contains minerals which plants require. Thus the minerals which plants take out of the soil are partly restored by the aid of soil bacteria.

When the study of soil bacteria was first commenced a curious fact was observed. Methods have been devised for counting the average number of bacteria present in a gram of soil. It was found that one day there might be about fifty million bacteria in a gram of soil. On the second day this number would be found to have fallen to about six million per gram, on the third day it would have risen again to about, say, forty million. This regular daily variation was discovered to be due to the presence in the soil of minute micro-organisms known as protozoa, which attack and destroy the bacteria. This soon reduces the number of bacteria, but by rapid reproduction they are able to increase their numbers again.

Thus the rise and fall in numbers of bacteria in the soil goes on.

Since we have seen what valuable work is done by soil bacteria, it is clear that soil protozoa by destroying soil bacteria are a nuisance. Methods have been discovered for destroying the protozoa and allowing the bacteria to live. This is known as partial sterilisation of soil.

Bacteria have a spore stage in which they are able to resist a certain amount of heat. Soil protozoa cannot do this. By heating soil once for a short while, the protozoa and bacteria in the ordinary stage are destroyed, but the bacteria in the spore stage survive. When these soil bacteria spores change to the ordinary state they increase rapidly in numbers, for their enemies, the protozoa, are destroyed. Partially sterilised soil thus quickly becomes the home of a busy horde of bacteria actively producing nitrates and other plant foods. Plants grown in partially sterilised soil usually grow better than plants growing in ordinary soil.

To show the effect of partially sterilising soil on plants growing in it. Fill a cocoa tin with ordinary garden soil, place it in the steam steriliser, and steam-heat for two or three hours. If you wish, you may instead place the tin of soil in a hot-air oven for two or three hours. Obtain two plant pots which have been thoroughly washed in a solution of formaldehyde to kill any protozoa or bacteria which may be on them. Fill one pot with the cooled, partially sterilised soil, and the other with ordinary garden soil. Plant in each a young tomato plant or sow some wheat or lettuce seeds. Notice any difference in growth over a period of several weeks.

QUESTIONS TO ANSWER

1. What are micro-organisms?
2. Make drawings to illustrate the different forms of bacteria.
3. Describe the chief activities of bacteria.
4. What is meant by the following: *bacteriologist*, *sterilisation*, *steriliser*, *partial sterilisation*, *preservative*, *culture medium*, *inoculation*?
5. How would you prepare apparatus for experiments on bacteria?
6. How would you show that there are bacteria in the air of the room?
7. How would you show there were bacteria (*a*) in your mouth, (*b*) in your hair, (*c*) on your clothes?
8. Bacteria cause decay. In what ways can this (*a*) be helpful, (*b*) be a nuisance?
9. Name several other ways in which bacteria are helpful.
10. What methods are used to preserve foods?
11. What is the work of soil bacteria?
12. Why do some gardeners use sulphate of ammonia when they make a compost heap?
13. What is the value of partial sterilisation of soil?
14. Find out what the following people discovered about bacteria: Leeuwenhoek, Louis Pasteur, Robert Koch.

PROJECT WORK

1. Prepare an exhibition on bacteria, using the following material:
   a. Cultures of bacteria from various sources.
   b. Drawings and photographs of bacteria.
   c. Microscope and micro-projectors with slides of bacteria.
   d. Experiments and materials to show some of the work done by bacteria.

CHAPTER FIVE

HEALTH AND DISEASE

WHEN all the cells and organs of our body are in a good sound condition, when they are doing their work easily and well, when they are getting their correct food and oxygen supplies, when all waste is being excreted, and when the conditions under which we are living are favourable, we are in a state of good health. Our good health depends upon the harmonious working together of all the parts of the body, and good health leads to greater happiness and a fuller life.

But often this state of good health is not maintained. The harmonious working together of all parts of the body is upset, and a state of ill health sets in. Then a person cannot attain full happiness and is unable to do his work really well. If the balanced working of the body is badly disorganised, then the person is ill at ease, that is *dis-eased*.

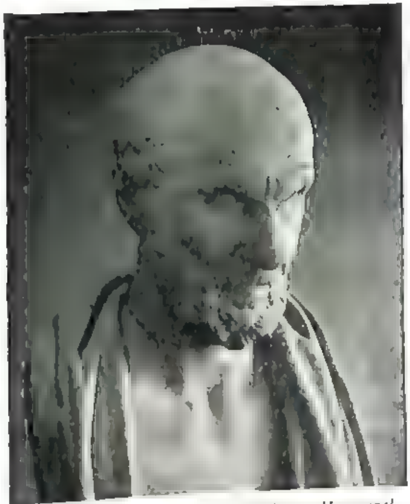
CAUSES OF DISEASE. Throughout the ages, man has been interested in the cause of disease, and the explanations they gave in early times sound very strange to us. Two thousand years ago, it was thought that disease was caused by evil spirits or devils entering the body. You will have come across several instances of this in the Bible.

> When the even was come, they brought unto him many that were possessed with devils: and he cast out the spirits with his word, and healed all that were sick (St. Matthew, ch. 8, v. 16).

Since it was generally believed that disease was due to spirits and devils entering the body from outside, the only

method of cure was to use spiritual methods or else magic, witchcraft, and sacrifices to the gods.

About 400 B.C., a Greek philosopher, Hippocrates, put forward a more scientific view. He said that disease was caused by something going wrong inside the body, and therefore could only be healed by careful observation of the patient, and, if necessary, by operation. In his notes, which we still possess, we can see how carefully he noted down symptoms and his ways of treatment. Because of this, he is often called the "Father of Modern Medicine". Hippocrates suggested that there were four *humours* or fluids in the body—red humour or blood, white humour or phlegm, yellow humour or bile, and black humour or black bile. If these, said Hippocrates, are not in the right proportions in the body, disease results. There was no microscope in the time of Hippocrates to enable him to see that this theory was not a very good one.



(By courtesy of the Wellcome Historical Medical Museum)

Hippocrates

Besides practising as a doctor, Hippocrates also trained young men to be doctors; but before they were allowed to practise he made them swear what has become known as the Hippocratic Oath. By this, the students vowed to do all that they possibly could to heal a sick person, no matter who he was, and to keep secret anything they had

learned from a patient during consultation. Even to this day, a doctor must swear to a modified form of this oath before he is allowed to practise.

There are many ways in which the working of the organs of the body can be disturbed. Incorrect feeding causes such deficiency diseases as scurvy and rickets. Bad habits—eating too much, smoking too much, drinking too much alcohol, getting insufficient sleep—lead to ill health. So, too, does not getting rid of the waste products of the body. Sometimes disease may be due to the faulty working of some organs of the body. For example, anaemia may be due to the failure of the blood-producing organs to make sufficient red corpuscles. Under-activity or over-activity of certain glands leads to various diseases. Disease also may be caused by some accident, or by irritation, to some part of the body. Smoke, dust, and fumes, for example, can cause irritation in the lungs. In very smoky towns and cities the number of people suffering from lung diseases is much higher than in less smoky towns and rural areas.

Worry, too, is responsible for much ill health. It often lowers the resistance of the body to other forms of sickness, and nervous illness in which the nervous system is upset is usually due to worry of some kind. When a person is worried he cannot be happy. This not only affects his nervous system but frequently upsets his digestive system and causes digestive troubles. Worry and nerve strain often reveal themselves in the most curious ways. A workman may not get on well with his foreman or manager. There will be constant irritation between the two, and this may set up a nervous strain in one or other, which may show itself in the form of dermatitis (a skin disease). You can understand this more easily if you remember that the skin is really a vast network of nerve-endings and therefore is part of the nervous

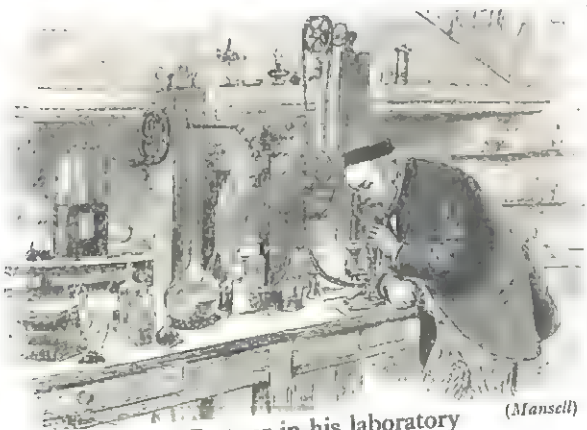
system which is under the strain.

(The Royal Society Collection)

Anthony van Leeuwenhoek

Not all diseases, however, are due to these causes. For many years doctors and biologists were puzzled about the causes of many of the diseases which afflicted man, plants, and animals. Indeed, it was not until the second half of the nineteenth century that the cause of many diseases was discovered.

In the seventeenth century a Dutchman, Anthony van Leeuwenhoek (1632–1723), experimented with lenses and made the first microscopes. He was the first to observe the microscopic living things present in stagnant water, and was probably the first to observe bacteria. A Frenchman,

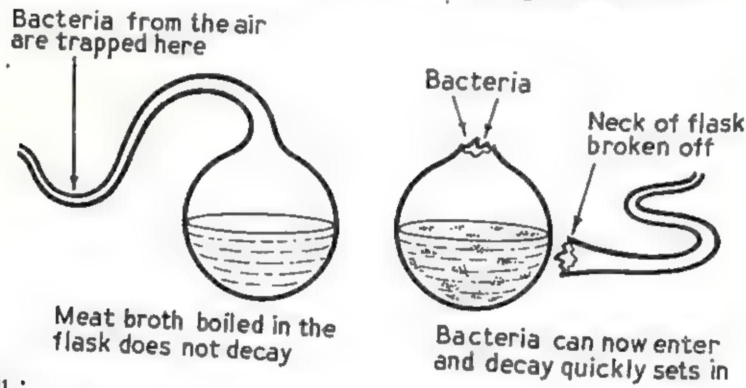


(Mansell)

Louis Pasteur in his laboratory

Louis Pasteur (1822–95), was the first really to study bacteria nearly two centuries later. During some investigations on the souring of wine he discovered that the fermentation of wine and beer was due to micro-organisms. In later experiments he proved that there were bacteria in the air, and that some of these bacteria were responsible for foods decaying and for dead plants and animals rotting.

Here is the experiment by which he proved this:



This suggested to Pasteur that possibly bacteria might be responsible for some diseases and for putrefaction in wounds. Soon after he had finished these experiments, Pasteur was called in to help the great silk industry of France, which was threatened by a disease which spread rapidly amongst the silkworms and killed them off. After much patient work, Pasteur discovered that the silkworm disease was caused by bacteria. This was the first proof of Pasteur's theory that some diseases are caused by bacteria.

About the same time, a German doctor, Robert Koch (1843–1910), was the first to prove that anthrax, a disease from which animals suffer, was due to bacteria. Later still, he proved that certain diseases in human beings, including tuberculosis, are caused by bacteria.

Robert Koch in his laboratory (*Mansell*)

When Pasteur, Koch, and other workers had proved that micro-organisms caused disease, the next steps were to discover how micro-organisms caused disease and the ways in which disease micro-organisms are spread.

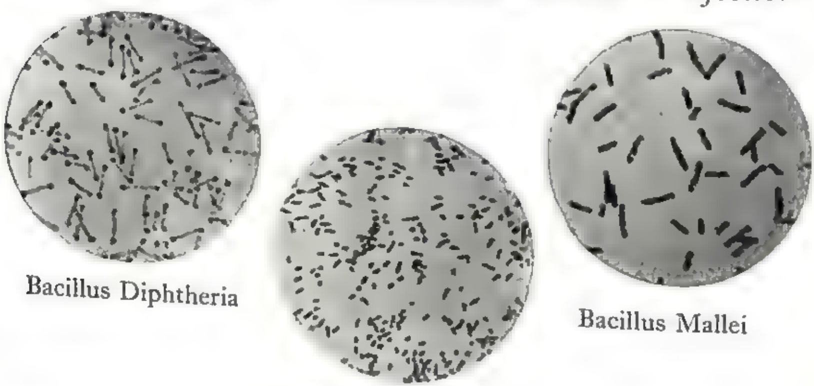
Bacteria and viruses enter the body through the openings into the body—the nose, mouth, eyes, and anus, or through a cut or wound in the skin. They multiply rapidly in the warm, dark, moist interior, and begin to feed on the body cells and fluids and to produce or excrete several waste products which we call *toxins*. These toxins are poisons. When they are produced in sufficient quantities they upset the working of the body and thus cause dis-ease.

The micro-organisms known as protozoa, and also the worms which are capable of living in the body, usually cause disease by the destruction of cells in the body. For example, the protozoa responsible for malaria and the hookworm are deadly because they destroy vast numbers of the blood cells.

HOW DISEASE MICRO-ORGANISMS ARE SPREAD. Disease bacteria and viruses are spread in various ways and it is important that these should be known.

By actual contact with a person suffering from a disease or with anything he or she has worn or handled, the disease germs may spread to other people. Many of the skin diseases are spread in this way. If a person uses a towel which has previously been used by someone suffering from a skin disease, then he may get some of the bacteria or viruses on his skin and thus catch the disease. Scarlet fever, influenza, smallpox, and measles are spread by actual contact, and are called *contagious* diseases.

When a victim of some disease coughs, spits, or sneezes, he sends out millions of harmful bacteria or viruses into the air. When the spit dries, the bacteria or viruses float in the air and are breathed in by other people. If the bodily health of these people is not good, they also may become victims. Diseases spread in this way are known as *infectious*



Bacillus Diphtheria

Bacillus Mallei

Micrococcus Melitensis

You know which one of these causes disease in human beings: can you find out from a book on bacteriology whether the others are responsible for any disease?

diseases. Influenza, diphtheria, tuberculosis, whooping cough, pneumonia, scarlet fever, and measles are infectious diseases.

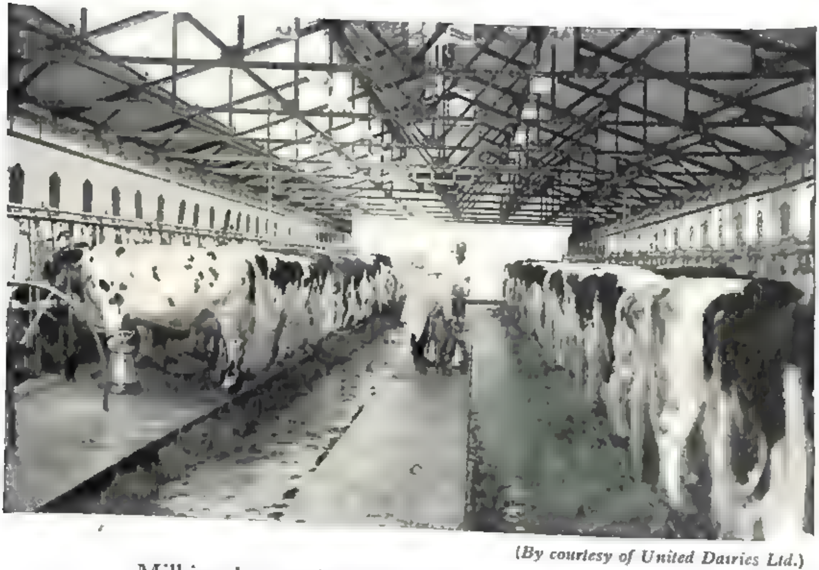
Disease micro-organisms may be spread in milk, food, and water. Cows may suffer from tuberculosis and the milk they produce will be infected with tuberculosis bacteria. People drinking this milk will, if in a low state of health, get tuberculosis. Typhoid fever and dysentery are two diseases spread by drinking water which has been fouled by contact with drainage water. In October 1937, an outbreak of typhoid started in a certain town in England and resulted in 311 cases of the disease and forty-two deaths. Investigators found that one of the wells supplying water to the town had been undergoing repair. Amongst the workmen was one who was a typhoid carrier. Along with others of the workmen he had used the ground near the well as a privy, and typhoid bacteria from his excreta had passed into the well water, which had become infected.

Quite recently a number of people suffered from food-poisoning after eating a trifle. The food of which the trifle was made was quite sound and the place where it was made was quite clean; but one of the girls engaged in making it had a stye on her eye, and probably in wiping her eye she transferred some micro-organisms from the stye to the trifle, which thus became infected and made the people who ate it ill.

In recent years there has been a considerable increase in outbreaks of food-poisoning, owing to the fact that more people are eating meals in communal conditions—canteens, cafés, and schools. Unfortunately, in many cases the conditions under which the meals are prepared are not of a high standard, or the people engaged in preparing and serving the food are sometimes not too clean in their

(By courtesy of United Dairies Ltd.)

Out-of-date and insanitary conditions of milking can quickly infect milk with dangerous micro-organisms



(By courtesy of United Dairies Ltd.)

Milking by machine in a modern milking shed. How many improvements can you spot?

habits. They may not, for example, wash their hands after they have used the toilet. Food thus becomes infected with micro-organisms and there is an outbreak of food-poisoning.

Animals, especially insects, do a great deal to spread disease micro-organisms.

You can do a little experiment to illustrate this. You will require two sterilised Petri dishes already prepared with sterilised culture medium. Raise the lid of one Petri dish carefully and introduce a live housefly. Allow it to walk for a few seconds over the surface of the medium. The second dish is to be used as a control and left as it was. Place both dishes in a warm dark cupboard for a few days, then examine. The control dish should still be clear, but the surface of the culture medium in the second dish will be streaked with trails of bacteria colonies wherever the housefly walked.

Perhaps some houseflies have been crawling over, and feeding on, a rubbish heap or sewage or excreta infected with typhoid bacilli. These flies now enter houses, crawl over the food on the table, or fall into the milk jug and thus infect the food. We have already seen how the mosquito spreads the micro-organisms responsible for malaria and yellow fever, how the tsetse fly spreads the micro-organism which causes sleeping sickness, and how bugs, fleas, and lice play their part in carrying disease micro-organisms, and therefore should be destroyed.

Apart from all these ways by which disease micro-organisms are carried, there is another method which is extremely dangerous and a source of great trouble. There are some people who can have disease bacteria in their body and yet not suffer from their presence. Some people, for example, may have large colonies of diphtheria bacteria in their mouths and throats and yet be quite free from diphtheria. In some way their bodies are immune or free from any attack. Such people are called *carriers* and are

one of the greatest sources of danger in spreading disease. If a person who is a "carrier" of diphtheria bacteria goes to the cinema or to a meeting, he may unknowingly infect neighbouring people. As he breathes out, his breath will contain diphtheria bacteria, some of which will be breathed in by other people who are not immune and liable to suffer from diphtheria. A "carrier" working in a bakery or place where food is produced or sold is a particular source of trouble.

Ill health also helps in the spread of disease by reducing the disease-resisting powers of the body and weakening its defences. The body is thus more open to the attacks of bacteria.

Certain types of work make a person more liable to attacks from disease bacteria than others. Thus, the throats and lungs of workers in mines, quarries, masons' yards, kilns, and some factories may often be damaged by stone or metal dust. This makes the throats and lungs of these people more open to attacks from bacteria.

SOCIAL CONDITIONS LEADING TO DISEASE. So far we have discussed what we may call the direct causes of disease. There are indirect ways in which disease may be caused, and amongst the most important are *social conditions*. This is clearly seen when we inquire into the incidence, that is, the occurrence, of a disease like tuberculosis. Tuberculosis can be spread by drinking infected milk or by constant breathing of air containing tuberculosis bacteria. Because of this second reason it is obvious that people living in overcrowded, bad housing conditions will run far more risk of getting tuberculosis than people living in houses with plenty of garden space around them.

When the Industrial Revolution was in full swing in the nineteenth century, house-builders crowded as many

houses as possible on to a piece of land, so that they could obtain as much rent money as possible. They did not consider the health of the people who would live in the houses. Frequently the houses were built back-to-back, that is, in rows with no garden or backyard between the houses in one street and the houses in the next street. The rooms and windows were small, so that ventilation was very difficult. There was only one lavatory to six or more houses. Such houses, as well as rows of small houses with tiny backyards, are still to be found in many parts of the country, particularly in the industrial towns. Amongst people living in these conditions the number suffering from tuberculosis is likely to be much higher than in the rest of the country. In the over-crowded housing conditions of the industrial towns and cities of Lancashire in 1928, for example, tuberculosis amongst very young children was nineteen times higher than amongst children of the same age all over the country. This overcrowding of houses on to a small area of land is made worse in many cases by the overcrowding of families inside the houses, so that several members of a family may have to live, eat, and sleep in one or two very small rooms. Imagine the effect of one person suffering from tuberculosis or falling ill with influenza or diphtheria in such crowded conditions.

Also, living under such conditions has a very depressing effect. The people in many cases lose their self-respect and begin to take less care in the appearance of the homes and themselves. They become dirty and slovenly, and this makes them less able to resist disease, and increases the occurrence of lice, bugs, flies, and the mite causing scabies.

Over-crowding and bad housing conditions are not the only social conditions leading to disease. Low wage income also frequently leads to an increase in disease and

a higher death rate. A child born into a better-off home usually stands a greater chance of survival and is less likely to catch certain diseases than a child born into a very poor family.

Not only is the risk of becoming ill greater amongst the lower wage groups, but when they do fall ill, they are usually ill for longer periods of time than the higher wage groups. This is a serious matter, for since they are ill for longer periods, their wage-earning is reduced still further, and this leads to more worry and distress, which still further lowers the resistance of the person or family to disease. To overcome this, National Insurance was introduced.

Poverty resulting from low wages, unemployment, ill health, and large families is responsible for much of the

(Bill Brandt)

A slum bedroom

disease from which people suffer. Poverty means that a family cannot afford to live in good housing conditions. It is forced to live in small houses in narrow, sunless streets, in ill-ventilated rooms which are dark and damp and often cold and cheerless. The family is unable to buy enough good clothing, and cannot afford to buy good food in sufficient quantities. The mother of a poor family too often has to buy cheap foods of low nutritional value, and thus the family are deprived of balanced meals and are faced with malnutrition. Such a family is constantly under the strain of living from hand-to-mouth, with no money to spend on holidays to break the monotony of the daily struggle. However, the wages of lower-paid workers are now much more adequate than they were a few years ago, and so things are much better in the matter of health.

But we must realise that not all malnutrition is due to poverty. Some is due to ignorance about food, and some to foolish spending and bad housekeeping. In some families where the income is sufficient to provide good living conditions, too much is spent on football pools and drink and smoking, leaving far too little to be spent on food and clothing.

Poverty leads to more than poor housing and malnutrition; it also means anxiety as to how to keep the family going, and worry as to where the next meals and clothing are coming from.

Other agents in the spread of disease are the insanitary conditions under which many people even today have to live. The absence of good sewerage systems had a great deal to do with the epidemics and plagues which used regularly to sweep the country and kill large numbers of the population. Indeed, it was the epidemics of cholera in the middle of the nineteenth century which led to the demand for better sanitary systems. Foremost in this

battle for better sanitary systems was Edwin Chadwick. His great work resulted in the 1875 Public Health Act, by which towns and cities were compelled to appoint sanitary inspectors and medical officers of health. Further Health Acts have been passed since then, but even yet there are many houses, especially in country districts, which have no water-closets or adequate methods for disposal of sewage. There are still many towns where the sewage is sent direct into a river or into the sea, instead of being treated in a special way and made harmless. Collecting and disposing of refuse can still be improved. In quite a large number of towns and rural areas the refuse is just dumped on a refuse-dump or tip to become a breeding ground for harmful bacteria, rats, mice, and houseflies.

Everyone knows the saying, "Where there's dirt, there's

(G. P. Murgatroyd)

Refuse from house bins being tipped on waste ground. What faults do you note in this method of disposing of refuse?

danger", yet not everyone realises how much personal uncleanliness there still is in this country. When families were evacuated during the Second World War, a surprising number of people were found to be infested with lice or suffering from scabies, or to have unclean and untidy habits. This uncleanliness can lead to disease.

There is also still a great deal of unnecessary dirtiness and carelessness in many shops. Food should not be handled in shops during serving, and care should be taken to keep food out of reach of houseflies. Clean shops, with wrapped goods served by scrupulously clean assistants, can help a lot to avoid disease. So choose a clean shop when you are buying sweets or food.

In discussing the occurrence and spread of disease we have been largely concerned with conditions in Great Britain. On turning to tropical and sub-tropical areas we find an appalling state of affairs. Disease is widespread and the general standard of health extremely low. In a study of South African Bantu school-children made in 1938–9, it was found that signs of ill health and malnutrition varied from 44 per cent in one area to 90 per cent in another area.

In many countries health conditions are still very primitive. Lack of sanitation and of clean drinking water, help swarms of flies and mosquitoes to spread disease. Lack of doctors and chemists and simple household medicines prevent the diseases being cured. Malnutrition from poverty and ignorance keeps the people feeble and more susceptible to disease.

DISEASE IN ANIMALS AND PLANTS. So far we have read about disease in human beings. Animals and plants also suffer from disease. Animals may get pneumonia, influenza, and tuberculosis through attacks from viruses and bacteria.

Foot-and-mouth disease in cattle, rabies and distemper in dogs, fowl plague in poultry, are all virus diseases.

Animals get these diseases in various ways. The bacteria and viruses may enter the body of an animal through the air it breathes, through the food it eats, through a wound, or through contact with a sick animal. In certain parts of Africa it is impossible to rear cattle, for they so readily fall victims to a disease caused by protozoa which are carried from one animal to another by the tsetse fly in almost the same way as the mosquito carries malaria to man.

Worms and fungi also cause disease amongst animals. Pigs often suffer from a disease due to worms, and sheep are attacked by a flat worm, the liver fluke.

Like human beings, animals can also suffer severely from deficiency diseases. The first animals kept in zoos died rapidly because of the lack of vitamins in their food.

(By courtesy of the Rowett Research Institute)

Calcium as well as vitamin D produced by sunlight is required for growth. (Vitamin D can also be obtained in cod liver oil and certain other foodstuffs.) Both these pigs had the same rations and the same sunlight, but the pig on the left had an extra dose of calcium

Young pigs frequently suffer from anaemia if their food is deficient in iron.

Plants are also attacked by viruses, bacteria, fungi, and worms; and frequently whole crops may be infected and destroyed. Some viruses, bacteria, and fungi spores float about in the air and are carried from plant to plant by the wind. Other plant diseases are caused by disease-causing organisms in the soil. Potatoes may suffer from wart disease. The fungus causing the disease does not destroy one crop only, but remains in the soil to infect other crops of potatoes in later years. Brown rot in apples and celery leaf spot are two of many plant diseases caused by fungi. Perhaps when you have been out in the country, you have seen sycamore trees whose leaves are covered with black spots. These black spots are moulds or fungi attacking the

(*Photos by courtesy of Rothamsted Experimental Station*)

Tomato suffering from an attack of Fern-leaf virus

Potato attacked by fungus causing Wart Disease

sycamore leaves. Wheat smut is a fungus disease on wheat, and at one time threatened the world's wheat supply.

The swollen shoot virus has threatened the world's cocoa supply, as well as the prosperity of Ghana. Reversion in black currants, mosaic disease in tomatoes and tobacco plants, and sugar-beet yellows are a few of the many virus diseases from which plants suffer.

Like man and animals, plants can also suffer from deficiency diseases. Fruit trees and vegetables growing in the garden soon show signs of ill health if nitrogen, phosphates or any other necessary mineral is missing from the soil.

(*Ghana Information Services*)

Typical swelling produced by the Swollen Shoot virus that has killed large areas of cocoa trees

WORK TO DO AND QUESTIONS TO ANSWER

1. Look up the words *health*, *disease*, and *hygiene* in an encyclopaedia or dictionary.
2. Find from an encyclopaedia all you can about Hippocrates.
3. Why was Hippocrates' theory about disease better than the belief that disease was due to evil spirits?
4. Make a list of the various causes of disease and give examples of each.
5. What part was played by each of the following in the discovery that micro-organisms cause disease: Leeuwenhoek, Pasteur, Koch?
6. What is the difference between *contagious* disease and an *infectious* disease?
7. Make a list of the ways in which disease micro-organisms can be spread.
8. Make a list of diseases spread by animals and say which animals are concerned.
9. What is meant by a *carrier*? Why are they an especial danger?
10. Using your history and social study books, write an account of housing conditions during the Industrial Revolution.
11. Why would you expect a higher incidence of tuberculosis in overcrowded conditions?
12. What is the relation between health and (*a*) bad housing, (*b*) income, (*c*) size of family?
13. What diseases would you say were largely the result of bad social conditions?
14. From history books, books on public health, and encyclopaedias find what you can about Edwin Chadwick.
15. Why is the standard of health in many communities so low?
16. Make a list of animal diseases, and say if they were caused by bacteria, viruses, protozoa, or fungi.
17. Choose two animal diseases and write an illustrated account of them.
18. Find out all you can about the liver fluke and its life-cycle and about ways of protecting sheep from it.
19. Make a list of some common plant diseases, and say how they are caused.
20. Choose two plant diseases, and write an illustrated account of them.

PROJECT WORK ON "HEALTH AND DISEASE"

1. If you live in a city or town, obtain a large-scale map of your district. Make a survey of the town, and on the map mark what you consider overcrowded and bad housing areas.

   From the Public Health Department obtain figures, if possible, showing the incidence of tuberculosis, diphtheria, etc., in various parts of the town. Find from your investigations if there is any relation between overcrowding, bad housing, and the incidence of disease. Make posters, graphs, and a written report to illustrate your findings.
2. Make a collection of photographs and drawings of bad housing conditions in your area.
3. Obtain the Medical Officer's reports for your town or county over a period of years. Study the figures there for various diseases and make graphs showing the incidence year by year.
4. If you live in the country, make a study of two or three common animal diseases and the treatment for them. Make an exhibition of your work, using photographs, graphs, illustrations, specimens, etc.

   Do the same for two or three plant diseases.
5. Find what diseases the children in your class have had and, if possible, when they had them. Make a graph of your findings.

CHAPTER SIX

THE FIGHT AGAINST DISEASE (1)

WE have now learned something about how diseases are caused and how they are spread. Every year thousands of lives and millions of work-hours are lost through disease. Indeed, the damage done is so great that many doctors, biologists, chemists, and Government authorities are engaged in a great battle against disease. Many biologists and doctors are very busily studying and performing experiments to increase our knowledge of the body and its functions, for the more we know about our body the better we know how to keep it healthy. By the publication of leaflets and books, by talks on the radio, by television and through films, people are learning more about ways of keeping healthy, and about disease and how to prevent it. Biology is now taught in most secondary schools and boys and girls are told about health matters, and about disease and its prevention. We are now going to see how man fights against disease.

THE BODY'S OWN DEFENCES. Our body itself has several defences against the attacks of disease organisms. The first line of defence is the *skin*, provided it is not cut, wounded, or broken. Few micro-organisms can get through the skin if it is clean and unbroken.

Quite a large number of micro-organisms enter our body through the openings of the nose, mouth, eyes, and anus, and also through cuts and wounds. Few people think that bacteria and viruses can enter the body through the bony cavity around the eyes. Fortunately, as well as

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(*By courtesy of the Wellcome Historical Medical Museum*)

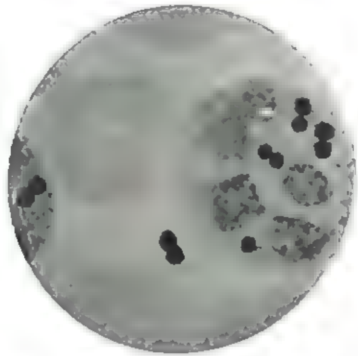
A statue of Aesculapius, the Greek god of Healing, with his goddess-daughter, Hygieia. What word connected with Health do we get from the daughter's name?

tears, glands near the eye also produce a highly antiseptic fluid which pours out with the tears on to the eyelids and kills the invaders.

Lining the inside of the nose, mouth, throat, gullet, and stomach is a very delicate membrane known as the mucus membrane. This produces a sticky fluid known as *mucus* in which the bacteria are trapped. Vast numbers of cilia or protoplasmic threads also line the nose and throat. These are constantly waving about and help to waft the mucus with its trapped bacteria up to the nose and mouth, from where we can get rid of it. By breathing through the nose instead of the mouth we can help the body in its fight against disease, for the nose acts as a filter and trap for dust and bacteria. The gastric juice produced in the stomach contains a little dilute acid which destroys many of the bacteria we swallow with our food. All these fluids make up the body's second line of defence.

The body's third line of defence is the *white blood cells*. Wherever bacteria get into the body, vast numbers of white blood cells are taken by the blood stream to the danger spot. These white blood cells are able to get out of the blood capillaries and proceed to the spot where the

harmful bacteria are. Just as an amoeba surrounds and ingests its food, so the white blood cells surround the bacteria, and destroy them. One white blood cell may surround, take in, and destroy several bacteria. The body, if it is in a healthy condition, will produce vast numbers of white blood cells and almost certainly win the fight. On the other hand, the bacteria may increase too rapidly, the white blood cells be unable to beat off the attack, and the person becomes a victim to the disease. Particularly does this happen when the body is in a low state of health, for then the white blood cells are not able to do their work properly. A healthy, fit body can resist disease bacteria much more readily than an unfit body.



In this micro-photograph you can see a white blood-cell absorbing and destroying the bacteria that cause boils, carbuncles, and the infection of wounds

Finally, the body has a fourth line of defence. We found that bacteria cause disease by producing poisons in the body known as toxins. Immediately bacteria enter the body and produce these toxins, the body replies by producing chemicals which neutralise or break down the toxins. These chemicals we call *antitoxins*. When diphtheria bacteria enter our body, the body at once begins to produce an antitoxin to neutralise the poison. If we are attacked by measles our body produces a measles antitoxin. Usually each antitoxin is capable of destroying only one kind of bacteria. Thus diphtheria antitoxin can only neutralise diphtheria and cannot destroy the toxin

produced by the measles organism. Our body, as well as producing chemicals which neutralise the toxins, also produces chemicals which kill the bacteria. When a person has recovered from some disease his blood will still have antitoxin in it and this will remain in his blood for some time. This prevents the person from getting the disease again for some time. We say the person is *immune* to that disease. Thus a boy or girl who has had measles and recovered will not catch it again for some time, or even during his or her life, because his or her blood will contain the measles antitoxin.

Good health is also important in the struggle against disease. The disease-resisting powers of a healthy body are much greater than those of a sickly body. A person may breathe in disease bacteria and these may live in the delicate lining of the throat without causing trouble. If this person now becomes tired through overwork or gets wet through or catches a chill, his disease-resisting power is weakened. At once the bacteria lying in his throat begin their deadly attack.

MAN AGAINST DISEASE. Just as man has always been interested in the cause of disease, so also has he been interested in curing disease. Some of the remedies and treatment used in days gone by sound extraordinary to us, being based largely on guess-work and witchcraft, just as is still the case amongst some primitive tribes. Here are a few of these old remedies:

ABRACADABRA BRACADABR RACADAB ACADA CAD A	This was a charm used by the Romans in the third century to keep away sickness. It was written on parchment, tied up with flax, and worn round the neck.

Here is a remedy taken from a tenth-century Saxon book on drugs:

"For headache take a vessel full of leaves of green rue, and a spoonful of mustard seed, rub together, add the white of an egg, a spoonful, that the salve may be thick. Smear with a feather on the side that is not sore."

This is a twelfth-century remedy for baldness:

"With mice fill an earthen pipkin, stop the mouth with a lump of clay, and bury it beside a fire, but so as the fire's too great heat reach it not. So let it be then for a year, and at the year's end take out whatever may be found therein. But it is urgent that he who shall lift it have a glove on his hand, lest at his fingers' end the hair come sprouting forth."

(By courtesy of the Wellcome Historical Medical Museum)

An operation 400 years ago. What do *you* know more than this famous brain-surgeon? What does a modern surgeon use that this one *could not*?

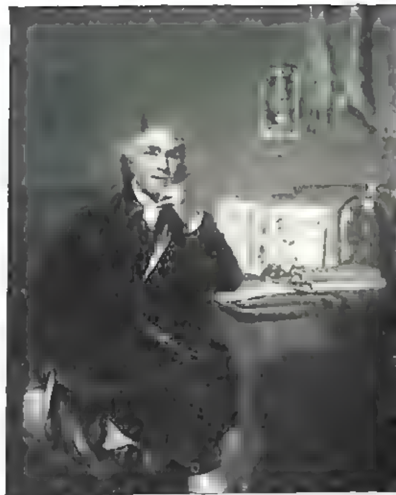
In the seventeeth century one of the most noted remedies against all manner of sickness was "Dr. Goddard's Drops". According to one formula these "drops" were made from hartshorn, portions of the skull of a criminal who had been hanged, dried vipers' bodies, and other horrible things.

When King Charles II fell suddenly ill the physician present had no lancet, but opened a vein with a pen-knife to let out blood, but this failed to cure him. More doctors were called in, and included in their treatment was the application of hot irons to his head, while a vile extract from crushed human skulls was even forced into him. But all to no avail.

(*Picture Post Library*)

Doctors wore clothing like this to protect them during the Great Plague of 1665 in London

What was true for medicine was equally true for surgery. Up to the eighteenth century amputation of a limb was performed very crudely, and indeed was practically butchery. John Hunter (1728–93), an English surgeon, showed that surgery could be done scientifically if the surgeon had expert knowledge of the structure and working of the body. He became a great teacher of doctors, and we may call him the "Father of Modern Surgery".



(By courtesy of the Wellcome Historical Medical Museum)

John Hunter, 1728–1793. Up to his time surgery had been a mechanical art; now it became a branch of scientific medicine, based on anatomy and physiology

But it was with the discoveries of Louis Pasteur and Robert Koch towards the end of the nineteenth century that the fight to prevent disease really began, and today the battle is still being waged furiously. Let us see now some of the ways in which man is fighting disease.

VACCINATION. We have already seen that a child who has had measles usually cannot have it again, because the child's blood will contain the measles antitoxin. Scientists and doctors have found out ways of getting the body to produce antitoxins which will guard and give it immunity against several diseases. These antitoxins are produced by injecting weakened or dead bacteria into the blood stream. The liquid containing the weakened or

dead bacteria is called a *vaccine*, and this method of fighting disease is known as *vaccination*.

The real pioneer of vaccination was an English doctor, Jenner (1749–1823). Smallpox caused the death or disfigurement of many thousands of people every year and spread terror everywhere. Edward Jenner had observed that country people who handled cattle very often caught from the cattle a very mild disease known as cowpox, and that these people never caught smallpox. This set Jenner thinking, and in 1798 he tried his first experiments in vaccination. From a cowpox blister on a dairymaid he obtained some *pus* or matter and rubbed this into a scratch on a boy's arm. The boy developed a mild, harmless attack of cowpox. A little later Jenner inoculated the boy with smallpox, but the boy did not fall ill with smallpox.

(*Picture Post Library*)

Two cartoons mocking Vaccination

"Mr. X's arms before Vaccination" "Mr. X's arms three days later"

He tried further experiments and at last was able to prove, in face of violent opposition at that time, that vaccination with cowpox made a person immune to smallpox.

Jenner did not know how vaccination worked. It was Louis Pasteur who later discovered this. Pasteur was born in 1822, the year before Jenner's death. He followed up Jenner's work by using the same method against such diseases as anthrax and hydrophobia. Pasteur discovered that if active anthrax bacteria were injected into a cow that had already suffered from anthrax, then the cow remained quite healthy and must therefore be immune against anthrax. He then suggested that cows should be vaccinated against anthrax, and he set to work to produce a weakened form of anthrax bacilli which would not kill the cow, but would give it a mild attack of anthrax, and thus make it immune to further larger attacks.

Pasteur then suggested using vaccination against hydrophobia, a dreadful disease caused by the bite of a mad dog. On July 6th, 1885, he had his first opportunity of using it. A nine-year-old boy, Joseph Meister, had been badly bitten by a mad dog. The boy's mother in despair rushed off to Paris with little Joseph and begged Pasteur to cure him. Pasteur hesitated, for he had only used vaccination on animals before; but, encouraged by some doctor friends, he inoculated the boy with a vaccine containing very weak hydrophobia bacteria. He repeated the vaccination over a period of days, each time using a stronger vaccine, then had to wait to see if it would succeed. We are told Pasteur could not stand the suspense and went away to his home village. There he waited and waited until, to his great joy, he received a telegram saying the boy had not fallen ill with hydrophobia. As a result of this success people from all over the world began to call on Pasteur for treatment, until at last a special building,

called the Pasteur Institute, was erected in Paris where vaccines could be made to be sent to all parts of the world. Such institutes or laboratories are now to be found in many places, where cultures of weak bacteria or vaccines are produced and sent out in tiny phials to doctors and hospitals.

Vaccination is used not only against smallpox or hydrophobia, but also against other diseases such as typhoid fever. During the Boer War, at the beginning of this century, more men died from typhoid fever than from bullets. This was because typhoid fever is caused by drinking dirty, polluted water, and in wartime men are living in bad sanitary conditions and drink whatever water they can find. In the Second World War very few soldiers died of typhoid fever because they were vaccinated against it. This vaccine was first made by a great English doctor, Sir Almroth Wright. Typhoid bacilli are grown on a specially prepared soup. When the culture has grown sufficiently, carbolic acid is added to kill the bacilli. These dead bacilli are now made into a vaccine, which is then injected into the body. Since the bacilli are dead they cause no disease, but the body does begin to produce anti-bodies or antitoxins. These remain in the body, and make it immune to typhoid fever over a number of years.

IMMUNISATION. In vaccination dead or weakened bacteria are injected into the body. By immunisation we usually mean the injection of poisonous toxins which have been made harmless. Perhaps you have been immunised against diphtheria. Let us see how this was done. In special laboratories some clear meat broth or soup is placed in a number of large bottles. The mouth of each bottle is plugged with cotton wool. The bottles are sterilised and placed on their sides on shelves in a dark warm room. A number of diphtheria bacilli are introduced into the

(*By courtesy of Evans' Medical Supplies Ltd.*)

This is a photograph of toxoid being prepared. What was done first to the bottles and the culture soup? What is the man doing?

soup in each bottle, and the bottles left for twelve to fourteen days. These cultures of bacilli develop rapidly and produce diphtheria toxin until the soup is full of it. The bacilli are then filtered off and a highly concentrated solution of diphtheria toxin is left. This is far too poisonous to use, so it is treated with a chemical called formalin, and then another chemical, alum, is added. This treated toxin is now known as *toxoid*, and it has lost so much of its poisonous property that it can be injected into a person without causing him to be ill with diphtheria. The toxoid is now tested on animals to find its strength, and is then

measured into tiny little bottles known as phials and sent out to doctors and clinics.

When you were immunised, the nurse or doctor gave you a very weak injection of diphtheria toxoid. This did you no harm, but, what is very important, it did cause your body to make antitoxin against diphtheria. You then went a second time and were given a stronger dose of toxoid. After this your body had learned to make its own diphtheria antitoxin. Now, if an epidemic of diphtheria occurs, a person who has *not* been immunised is likely to get diphtheria, but *you* won't. Diphtheria bacilli may get into your body, but since you have been immunised your body has already produced antitoxin and so you are immune to the disease.

DOES IMMUNISATION WORK? You can judge for yourself from the following figures about diphtheria in Britain. In 1941 a campaign was started to immunise young children against this disease, and by 1943 this campaign was well under way. What were the results of immunisation?

Year	1941	1942	1943	1944	1945	1946	1947
Cases of Diphtheria	50,797	41,404	34,662	23,199	18,596	11,986	5,609
Deaths from Diphtheria	2,641	1,827	1,371	934	722	472	244
Year	1948	1949	1950	1951	1952	1953	1954
Cases of Diphtheria	3,575	1,881	962	664	376	240	182
Deaths from Diphtheria	156	84	49	33	32	24	9

So you can see that if there had been no immunisation it seems certain that over 2,000 children would still be dying of diphtheria every year in Britain. It is the very

young to whom diphtheria is most deadly, and most deaths are of children under ten years old. Immunisation has almost ended this death-dealer. Does that mean that we can now regard diphtheria as a disease of the past and not bother any longer about immunisation? No. The doctors tell us that we can be sure of avoiding an epidemic of diphtheria only so long as at least seven out of every ten people are immunised. So if we are careless and do not bother, diphtheria may easily return as a death-dealer. And it is not any good saying we will wait until there is an outbreak of diphtheria and *then* we will get immunised, for this reason: it takes several weeks to develop immunity, so if we leave it until we think there is immediate danger we shall leave it too late.

ANTITOXIN OR SERUM TREATMENT. Both vaccination and immunisation are used to *prevent* a person from getting a disease. They encourage the person's body to produce the antitoxins itself. We can call them preventive measures. But if a person actually gets a disease it is too late then to vaccinate or immunise him against it. There is, however, another method we can use to help him defeat the bacteria attacking him, by injecting into his body antitoxin to neutralise the poisonous toxin the bacteria are producing. We use this method of antitoxin injection mainly against diphtheria and tetanus.

The antitoxin serum is made in an interesting way. At certain biological laboratories or institutes horses are injected with a weak form of diphtheria or tetanus bacteria or toxin. The horse at once begins to produce diphtheria antitoxin or tetanus antitoxin. Further injections of stronger doses of the bacteria or toxin are given at intervals until the blood of the horse contains a large proportion of antitoxin. Some of this blood is carefully drawn from

the horse, and a fluid called *serum* containing the antitoxin obtained from it. This is sent out in small phials. A patient suffering from diphtheria will then have injections of this antitoxin serum to assist him in the fight against the disease.

ANTISEPTICS AND DISINFECTANTS. The fight goes on in other ways too. A visit to a hospital one hundred years ago would have revealed a dreadful state of affairs. Operations were rarely successful. The wounds festered badly and stank horribly; a disease known as gangrene developed in the wound and quickly led to death. The cause was not known in those days, because Pasteur had only just started his experiments. Now we know the cause. The hospitals were not clean or well ventilated. The instruments used were often dirty, and the surgeons

(*Illustrated London News*)

Florence Nightingale walking with her lamp through the wards of a war hospital 100 years ago

performing the operations often did not wash their hands or change into clean overalls in passing from one patient to another. Thus bacteria entered the wounds and caused blood-poisoning or gangrene which led to death.

The high death-rate from operations caused grave concern to many surgeons, and especially to a British physician, Joseph Lister (1827–1912). While Pasteur was making his wonderful discoveries about disease bacteria, Lister was a surgeon in Glasgow Infirmary (1860–70). Pasteur's discoveries led Lister to believe that putrefaction and gangrene in wounds after an operation were due to bacteria entering the wound.

(By courtesy of the Wellcome Historical Medical Museum)

An operation in the early days of the antiseptic system. Note how the antiseptic was sprayed on the wound

(Mansell)

Joseph Lister

Lister began to search round for ways of preventing bacteria from getting into the wound, and found that if he washed his hands, his instruments, and the wound in carbolic acid, the wound remained clean and began to heal. Thus, Lister was the first to use *antiseptics* to prevent wounds going septic, by killing bacteria entering a wound and thus preventing blood-poisoning. In addition, he insisted that his ward should be kept scrupulously clean and that his assistants and nurses, as well as he himself, should be perfectly clean and should wear clean overalls. Lister was laughed at by surgeons of his time, but when they saw the operations in Lister's ward becoming more and more successful while the death-rate in other wards in the same hospital, but not in Lister's care, remained very high, they began to change their opinion.

Since Lister's first use of carbolic acid, far better antiseptics have been discovered. In the early days some antiseptics, such as carbolic acid, not only killed the bacteria, but often did harm by destroying also the flesh and white blood cells. Modern antiseptics do not destroy the flesh, but are bacteria-killers only.

In modern surgery we do more than just use antiseptics to destroy bacteria; we do everything possible to keep bacteria out of the operating theatre. The theatre is spotlessly clean. The instruments are sterilised with steam, and so also is the clothing worn by the surgeons, assistants, and nurses. Great care is taken in washing the hands. Sterile masks are worn over the mouth and nose to prevent

(Picture Post Library)

A modern operation. Compare this photograph with the drawings on pages 101 and 111. What improvements have taken place?

any bacteria being breathed out on to the patient. This is known as *aseptic surgery* ("germ-free" surgery).

Most of the disease bacteria which attack our body enter through the mouth and lodge in the throat. Mild antiseptics used as gargles to kill these bacteria are of some value.

Some chemicals are used to kill bacteria outside the body or in places where bacteria may lurk, such as sinks, lavatory bowls, and bins. These chemicals are called *disinfectants*. By a greater use of disinfectants the danger from bacteria would be greatly reduced.

Special methods of disinfecting are used to destroy bacteria in an infected building. A house from which some of the tenants have been taken to hospital with an infectious disease is disinfected by stoving or fumigation. Such articles as clothing and books will be taken by the health authorities and stoved or treated with certain disinfectants. The windows and all doors, except one, of the house are sealed. Chemicals are mixed or burnt in the house and the person doing the fumigation goes out and seals the only door left unsealed before. Fumes given off from the chemicals reach everywhere in the house and kill all the disease bacteria.

At seaports and airports great care is taken that persons or animals suffering from some disease do not enter the country. Each ship must be certified to have a clean bill of health. Animals are kept in quarantine to make sure that they are free from disease. When a ship on which there is a case of serious infectious disease arrives in a port it must fly a yellow flag. No one is allowed to land before being seen by a doctor; the ship must also be fumigated.

The greatest and cheapest disinfectant we have, however, is sunlight. Bacteria are killed by the ultra-violet rays of the sun. When the sun is shining into your room it is not only brightening up the room, but killing any bacteria which may lie in its rays.

DDT AND GAMMEXANE. The disinfectants we have just discussed are chemicals used to destroy micro-organisms causing disease. During the Second World War two chemicals were introduced, which are very useful for destroying the insects which spread disease-causing micro-organisms. These are DDT and Gammexane. DDT is the short name for a chemical some Swiss chemists discovered in 1940. It is a powerful insect-killer. Since then it has been used extensively against all forms of insect pests, particularly the housefly, mosquito, and louse. In 1943–4 a very serious epidemic of typhus broke out in the badly damaged city of Naples in Italy. Hundreds died of the disease, which threatened to spread all over the country. The carriers of the typhus micro-organisms were body-lice. An urgent call for DDT was made; the whole of the population were lined up at various centres and had DDT powder sprayed all over their clothes and body. Houses, shelters, and other places where lice might lodge were also sprayed with DDT powder and DDT solution. Almost immediately the epidemic died out. This indeed was a powerful weapon in the hands of men in the fight against disease.

During the Second World War, when it looked as if disease epidemics spread by insects might break out on a large scale, the search for powerful insect-killers became a very important matter. The chemists of I.C.I. (Imperial Chemical Industries) in England began to test a number of chemicals as insect-killers. Amongst those tested was one known as "666", discovered by the great English chemist Michael Faraday in 1825, and from this in 1942 they prepared a very powerful insecticide which they called "Gammexane". It has been used with particular success against mosquitoes and locusts by spraying it from aeroplanes.

ANAESTHETICS. Let us again visit a hospital a little over a hundred years ago. We have already noticed the uncleanliness of the place, and the stench from the putrefaction in the wounds. Suddenly we are horrified by the most frightful screams imaginable. An operation is in progress. The patient screams in agony until he faints from shock, and the surgeons work at immense speed to finish the operation. No time to do everything carefully; no time for exact work. The shock to the patient is so severe that the operation must be got over as quickly as possible. Sometimes strong men were employed to hold patients down; sometimes the patients were given rum to make them drunk. Few operations were successful, and very few internal operations could be performed.

How different it is now, when operations on almost all parts of the body can be safely undertaken. While he is still in the hospital ward, the patient is given tablets or injections, so that all fear of the operation is removed and he quietly falls asleep. He is then taken into the operating theatre, where, thanks to the latest anaesthetics, the surgeons are able to do their work carefully, accurately, and calmly, without any urgent haste, and without the slightest pain to the patient.

How did this change from ghastly butchery to painless surgery come about, and who was the first to use the pain-killers we call *anaesthetics*?

In 1800, the great English chemist, Humphry Davy, suggested that breathing in a gas called nitrous oxide might deaden pain during a surgical operation. (This gas, which is sometimes called "laughing gas" because of its peculiar effect on some people, is still used today when taking out several teeth.) Little further was done about the idea until an American doctor, William Thomas Morton (1819–68), began to experiment with ether as a

pain-killer. Here is Dr. Morton's own description of some of his experiments:

"Toward evening, a man residing in Boston came in suffering great pain, and wishing to have a tooth extracted. He was afraid of the operation. Saturating my handkerchief with ether, I gave it to him to inhale. He became unconscious almost immediately. It was dark, and Dr. Hayden held the lamp while I extracted a firmly rooted bicuspid tooth. There was not much alteration in the pulse, and no relaxation of the muscles. He recovered in a minute, and knew nothing of what had been done to him. He remained for some time talking about the experiment, and I took from him a certificate. This was on the 30th Sept., 1846.

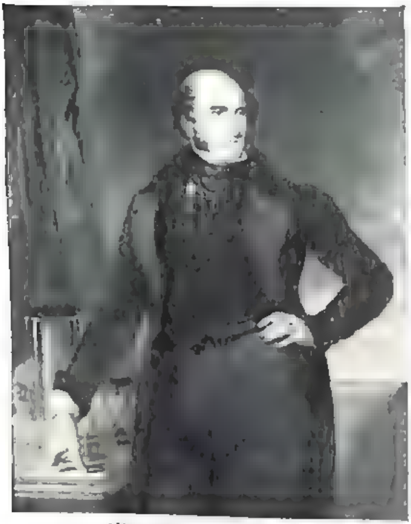
In the meantime I made several experiments in my office with various success. I administered it to a boy, but it produced no other effect than sickness, with vomiting, and the boy was taken home in a coach, and pronounced by a physician to be poisoned. His friends were excited and threatened proceedings against me.

Afterwards I gave it to a Miss L., a lady of about twenty-five. The effect upon her was rather alarming. She sprang up from the chair, leaped into the air, screamed, and was held down with difficulty. When she came to, she was unconscious of what had passed, but was willing to have it administered again, which I did with perfect success, extracting two molar teeth."

(By courtesy of the Wellcome Historical Medical Museum)

The first public demonstration by Dr. Morton of Anaesthesia with ether at Boston, U.S.A., on October 16th, 1846

On October 16th, 1846, Dr. Morton first used ether as an anaesthetic in a major operation at the Massachusetts General Hospital, Boston, U.S.A. This we can regard as the beginning of the use of anaesthetics in surgical operations.



(By courtesy of the Wellcome Historical Medical Museum)

Robert Liston

The news quickly spread throughout the world, and on December 21st, 1846, a great Scottish surgeon, Robert Liston, performed an operation, using ether, at University College Hospital, London.

Ether, however, was found to have unpleasant after-effects, and often caused severe vomiting. To overcome this a Scottish surgeon in Edinburgh, James Young Simpson (1811–70), began to experiment with various substances to find something better than ether as an anaesthetic. A chemist friend suggested that he should try a chemical known as chloroform. Simpson tried it out on himself and some friends; and then first used it in a major operation on November 8th, 1847.

Within recent years wonderful advances have been made, both in anaesthetics and in the methods of giving them. Usually we group them into two classes—local anaesthetics and general anaesthetics. Local anaesthetics like cocaine and novocaine deaden the pain nerve-endings in a small area of the body, e.g. just round a tooth or where

(By courtesy of the Wellcome Historical Medical Museum)

Dr. J. Y. Simpson and two friends discover for themselves the anaesthetic properties of chloroform

a small incision or cut has to be made. If a pin were stuck in the person anywhere else but in this spot he would, of course, feel the pain. A general anaesthetic like chloroform puts the part of the brain sensitive to pain out of action, and so no matter where an incision or cut is made you feel no pain.

The discovery of anaesthetics and Lister's discovery of the use of antiseptics have made possible the enormous advances in surgery.

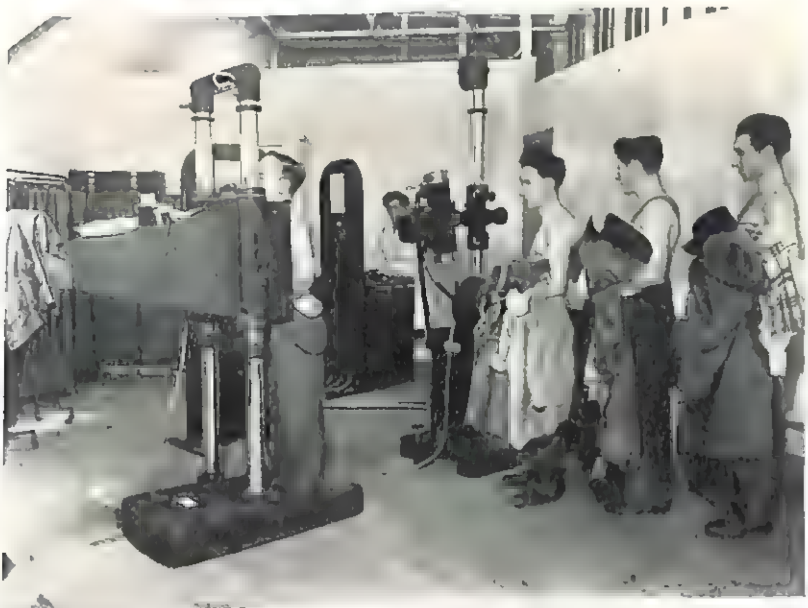
X-RAYS AND RADIOGRAPHY. When Professor Wilhelm Rontgen discovered X-rays in 1895 he certainly did not know what a useful weapon he was placing in the hands of the doctor. X-rays are radiations which can pass through solid objects. If X-rays are passed through the body and

allowed to fall on a photographic plate, we get a photograph of the inside of the body. The X-rays pass through muscle more easily than through bone, and so on the photograph we can easily see the dark outline of the bone. Thus one of the first uses of X-rays was to photograph fractured bones to enable the doctors to see exactly how the bone had broken. Later it was discovered that if certain chemicals which obstruct the passage of X-rays were swallowed or injected into the body, it was possible to take an X-ray photograph of the blood-vessels and other organs of the body as well as bone.

Research workers discovered that X-rays must be used with great care, as they destroy the cells of the body. The radioactive element radium does this also. This property of X-rays and radium has been made use of in the fight against cancer. The cells of the body, as you know, grow to a certain size, and then divide into two new cells. Sometimes cells, instead of dividing, go on growing bigger and bigger, and produce the growth we know as cancer. X-rays and radium are used in certain cases to destroy the cells which are causing the cancer. More recently still, X-rays have been used to cure a very nasty skin disease called dermatitis.

It is, perhaps, in the fight against tuberculosis that X-rays are proving most useful. A person may be suffering from tuberculosis for months, and even years, without knowing it. He will, in fact, appear to be quite healthy, until suddenly he becomes seriously ill with the disease. Treatment is then very difficult and very slow, for we do not yet have drugs which destroy the tubercle bacilli. If the disease can be detected in its very early stages, treatment can be given with a far greater chance of success. It is here that X-rays are of great value, for by making an X-ray photograph of a person we can tell if tuberculosis bacilli are present or not in the body.

This is now being done on a large scale through what we call *mass radiography*. The Public Health Departments of many towns have a radiography room. Any person who wishes to be examined for tuberculosis may go there. He strips to the waist, has his chest measured, and then stands for one second with his chest in front of the X-ray machine which is under the control of a trained radiographer. So quickly is this done that it is possible to X-ray about ten to twenty people every minute. The photographs, taken on 35-mm. cinematograph film, are quickly developed and examined by the doctor in charge. In this way the early stages of tuberculosis can be detected before the disease has become serious.



(By courtesy of Liverpool Daily Post and Echo Ltd.)

Mass radiography makes it possible to detect tuberculosis at an early stage when treatment is still easy

Many factories and firms send their employees along to be X-rayed as part of their welfare service, but soon it is hoped that each large firm will have its own radiography unit. It will probably be used in the medical examination of children at school.

Besides tuberculosis, radiography also reveals other diseases of the lungs, the heart, and the backbone.

TRACER ELEMENTS. One of the latest weapons in the hands of medical research workers has been provided by recent work on atomic energy. You will be aware that the chemical element radium is radioactive. This means it gives off rays or radiations, and these can be detected quite easily by special electrical instruments even in extremely minute amounts. Very few chemical elements have this property. By means of the atomic energy machines called piles it is possible to make any element radioactive for a long or short time. For example, the element carbon can be made radioactive. Now, much of the food we eat contains carbon, e.g. sugar and starch. Suppose a person ate some food containing carbon which was radioactive in such small amounts that would be harmless to the body. Then, by using electrical detectors, we would be able to trace the path of the radioactive carbon in the body and find out exactly what happens to it. Because of this we call the radioactive carbon a *tracer element*. Other elements in our food which go to make up our body, such as iron and phosphorus, can be made slightly radioactive, and we are able to find exactly what happens to them and where they go to in our body.

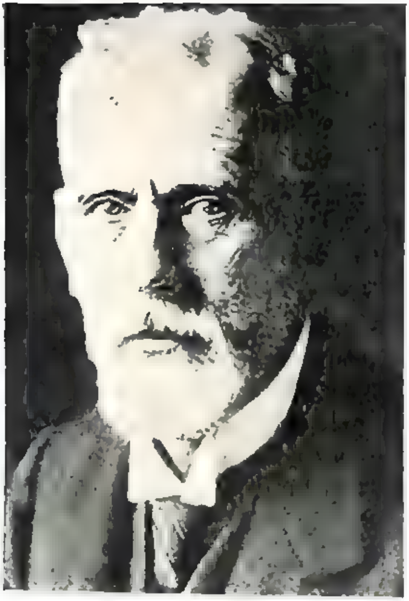
This has enabled doctors and students doing research work to find out much more than they would otherwise have done about the body and how it works. Furthermore, these tracer elements may be used to fight disease directly.

Cancer can very often be cured by radioactive radiations. Suppose the cancer is inside the body, say, in the thyroid gland, it is difficult to get at. Now that we can produce radioactive elements very cheaply, it may be possible to deal with the cancer in the thyroid in the following way. The thyroid gland in a person's body absorbs most of the iodine which may be in the food eaten. Suppose the person is given some iodine which is slightly radioactive. This will be absorbed by the thyroid and any cancer there will at once be attacked by the radiations. Unfortunately there are not many substances which go mostly to one place in the human body.

Thus atomic energy, in addition to producing power, is also helping in the healing of disease.

CHEMOTHERAPY OR INTERNAL ANTISEPTICS. Have you ever had an injection of penicillin? Penicillin is a drug used to combat certain disease micro-organisms inside the body without causing any harm to the body itself. Using chemicals in this way to destroy disease organisms in the body is known as *chemotherapy*, which means "healing by chemicals". The chemicals are like antiseptics which can be used inside the body. The discovery and use of such chemicals is one of the greatest advances of modern medicine.

PIONEER WORK. The pioneer was a German Jew, Paul Ehrlich (1854–1915), who was assisted in his work by two Japanese, Shiga and Hata. Ehrlich, while a medical student, became interested in the dyes which German chemical industries were then producing. Also, as a worker under Dr. Robert Koch, he became interested in disease micro-organisms. During his work he began to wonder if any of the new dyes might be useful as



(*Picture Post Library*)

Paul Ehrlich, pioneer of the use of drugs to destroy disease micro-organisms

germ-killers. He decided to experiment with them on a disease called syphilis, which was widespread at that time and for which the cures then used were slow, dangerous, and not always sure. Ehrlich and his assistants did experiment after experiment, using various substances. Some had little effect, some killed the bacteria causing the disease, but also, unfortunately, were harmful to the body. At last in 1909 he found that the 606th substance he tested destroyed the bacteria, and if used carefully had little harmful effect on the body. He named this substance "salvarsan" or "606". Ehrlich carried on the work and later discovered "neo-salvarsan", which was much more effective against syphilis than salvarsan. Neo-salvarsan is known as "914". Why?

In 1932 two chemists working in the great Bayer Laboratories in Germany produced several new dyes, and one of their colleagues, Gerhard Domagk, experimented with them to see if they would kill bacteria. Three years later, Domagk found that one of them, a red dye which became known as prontosil rubrum, was very effective against streptococci, the bacteria which cause amongst other things sore throat, tonsilitis, and scarlet fever. He

was one of the first to benefit by the discovery, for his young daughter became infected with streptococci and her life was saved only by the use of prontosil.

THE SULPHONAMIDES. The discovery of prontosil set scientists all over the world searching for other chemicals which would destroy bacteria.

In 1935 some French scientists working at the Pasteur Institute in Paris showed that a much simpler chemical, sulphanilamide, which had been produced in 1908, was just as effective as prontosil and much cheaper to produce.

This further encouraged research workers; and in the laboratories of May and Baker, manufacturing chemists, at Dagenham near London, a team of research workers under Dr. A. J. Ewins set to work to discover a drug which could be used against the pneumococcus, the bacterium responsible for pneumonia. After much hard work they succeeded in producing a chemical, *sulphapyridine*, which in their books was registered as T693. This was tried out and found to be successful by Dr. L. E. H. Whitby (now Sir Lionel Whitby) on mice and other animals which had been injected with pneumococci. On March 18th, 1938, a Norfolk farm labourer suffering from pneumonia, whose case was regarded as hopeless, was the first human being to be given sulphapyridine, and he made a remarkable recovery.

On May 28th, 1939, Dr. Whitby was able to announce that sulphapyridine was very effective in the treatment of pneumonia in human beings and had only an extremely slight poisonous effect. Other doctors quickly confirmed this. Very soon sulphapyridine became known to everybody as "M & B 693". You will easily see how it got this name. Production began on a large scale, and large quantities of "M & B 693" tablets and powder were sent

out to all parts of the world. From the date of the discovery of sulphapyridine, pneumonia has no longer been one of the world's most killing diseases.

Soon afterwards, in the research laboratories of May and Baker another drug was discovered, *sulphathiazole* or "M & B 760", which in some ways was even better than sulphapyridine. These drugs, together with others since discovered, are now known in this country as the "Sulphonamides" and in America as the "Sulfa-drugs". They are extremely powerful weapons in the hands of the doctor, and research goes on to discover even better sulphonamides. They are effective against pneumonia, infected wounds and burns, scarlet fever, meningitis, tonsilitis, sinusitis, cerebro-spinal fever, impetigo, boils, carbuncles, and whitlows. They have no effect on the organisms causing typhoid fever, food-poisoning, influenza, measles, smallpox, diphtheria, and tuberculosis.

You may be interested to know how these sulphonamides work. They do not kill the bacteria, neither do they neutralise the poisonous toxins the bacteria produce, but they do prevent the bacteria from multiplying rapidly. This gives the body's own defences, the white blood cells and antitoxins, a better chance to destroy the invading bacteria, and thus prevent the sickness from developing. What really happens is this. In order to grow and multiply, bacteria need a certain vitamin. Now, a sulphonamide drug is very similar in chemical structure to this vitamin. So when a sulphonamide is given to a sick person, the bacteria take up the sulphonamide instead of the vitamin. The sulphonamide is no use to the bacteria, but it does prevent them from getting the vitamin and so the bacteria cannot grow and multiply.

It is very important to give a large dose of a sulphonamide drug right at the start before there are too many

bacteria in the body, for sulphonamides are not too successful against large numbers of bacteria. It is also important to keep the amount of sulphonamide in the blood up to a certain level, so the doctor gives the patient further large doses at short, regular intervals. If ever you have to take M & B tablets or sulphonamides, you must only do so under a doctor's orders, and you must take them exactly how and when he tells you. If you miss a dose the whole treatment may be wasted. There is another very important reason why the first dose must be large and why you must take them just as the doctor says. If only small doses are given or if the amount in the blood stream falls too low, the bacteria become resistant to the sulphonamide and this resistance continues as the bacteria multiply, so that the drug becomes useless.

Sulphonamide drugs in the form of powder are sprinkled on open wounds to destroy any infectious material in them. During the Second World War this was frequently the first treatment given to wounded soldiers by the field ambulances; the field dressing carried by members of the United States Forces included eight tablets of sulphadiazine with instructions to take them, if possible, immediately on being wounded.

PENICILLIN. Another powerful weapon in the fight against disease was found at almost the same time.

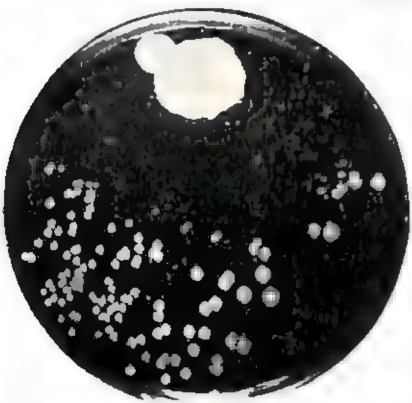
In 1928, Professor Alexander Fleming at St. Mary's Hospital, London, while experimenting with staphylococci bacteria, found that one of the Petri dishes he had inoculated with staphylococci had a blue-green mould growing on it. Any other person might have thrown the Petri dish away, as moulds often get in and ruin some culture experiments. But Professor Fleming noticed that the staphylococci round about the mould were all dead.

(Crown Copyright Reserved)

Sir Alexander Fleming

He began experimenting with the mould and in 1929 found that it was some substance given out by the blue-green mould which killed the staphylococci. The mould was one known by the name *penicillum notatum*, so Fleming named the substance it gave out *penicillin*.

He then showed by further experiments that penicillin killed other kinds of deadly bacteria, that it was



(British Journal of Experimental Pathology)

The original plate on which Sir Alexander Fleming made his discovery of Penicillin

not poisonous when injected into rabbits, and did not destroy white blood cells. He realised that he had discovered a powerful antiseptic, and tried it with some success in dressing wounds. Unfortunately, experiments performed by other biologists showed that penicillin was a very unstable substance and lost its antiseptic properties very quickly. It was thought, therefore, that it would have little

Petri dish with the mould *penicillium notatum* growing.

5*

use in medicine, and practically no further work was done on it until 1938.

In 1938, Professor Howard Florey, Dr. Ernst Chain, and other scientists at Oxford University decided to make

(Photos Crown Copyright Reserved)

Sir Howard Florey Dr. Ernst Chain

a study of bacteria-killing substances produced by bacteria and moulds. Such substances are now called *antibiotics*. One of the substances they decided to experiment on, very fortunately, was Fleming's penicillin. After two years of constant research they at last succeeded in obtaining, from the broth in which they had grown the penicillin, a brown powder which was found to be an extremely powerf[ul] bacteria destroyer. This brown powder was a crude form of penicillin, but from it they discovered:

1. That penicillin could be prepared in a fairly stable form provided it was kept cold.

2. That it could be used with deadly effect against the bacteria which cause septic poisoning, boils, carbuncles, and abscesses; pneumonia, pleurisy, anthrax, diphtheria, meningitis, inflammation of bone, gonorrhoea, syphilis, tetanus (lockjaw), and gas gangrene in wounds.
3. That it had little or no effect against diseases caused by protozoa such as malaria; virus diseases such as the common cold, influenza, and infantile paralysis; and against typhoid fever, dysentery, cholera, and tuberculosis.
4. That it had no harmful effect at all on the human body.
5. That it was effective even when diluted a million times.

It was clear that here was a very powerful antibiotic for the doctor to use, and in 1940–1 it was tried out on human beings for the first time with great success.

To begin with, penicillin could be made in very small quantities only, and was very expensive. By the middle of 1946, however, it was being produced on a large scale, so that it could be used by every doctor who needed it for his patients.

The pure penicillin used in hospitals and by doctors is sent out from the factory in small sterilised phials, and if kept cool it will be effective for two years. For injections it is diluted with sterilised water. It can also be used in powder form and ointments for applying to the skin and to wounds, in lotion form or as drops for eye infections, and as lozenges for infections of the tonsils and throat.

Like the sulphonamides, penicillin stops bacteria from multiplying, and thus gives the white blood cells and the

antitoxins the body produces a chance to destroy the bacteria. It is thought, too, that in strong concentrations penicillin also kills bacteria. It is usually given in large doses, since it has been discovered that if it is given in small doses over a long period, certain bacteria become resistant to it. The speed with which penicillin works is really amazing. With large injections of penicillin even large abscesses can be completely cleared in three or four days instead of in weeks or even months. (Before the days of penicillin the abscess might have made the person ill for weeks, possibly have led to other abscesses and other complications, and might even have required some surgical operation.)

Perhaps you are wondering which is the better drug, a sulphonamide or penicillin. Both are very useful. Sulphonamides are better against some bacteria than penicillin, and penicillin better than sulphonamides against others. Sometimes both are used together. (On one or two points penicillin has an advantage over the sulphonamides. It is probably more powerful in action; it works whether the number of bacteria is large or small; it is non-poisonous, fewer bacteria develop a resistance to it, and what is very important in the treatment of wounds, whereas the matter or pus in a wound stops the activity of sulphonamides, it does not stop the activity of penicillin.)

And so from the chance fall of a mould into a Petri dish of bacteria we have developed the most powerful drug, penicillin, but remember it was the trained eye of Professor Alexander Fleming which saw what the mould had apparently done to the bacteria in the Petri dish.

STREPTOMYCIN. The discovery that penicillin could be produced from moulds soon set scientists in biological laboratories all over the world searching for other moulds

which might yield other drugs. As you read this the search is being vigorously pursued by many scientists. In 1944, a group of scientists in the United States of America, under the direction of Dr. S. A. Waksman, obtained from a mould a drug known as *streptomycin*. Laboratory experiments showed that streptomycin was effective against the organisms which cause typhoid fever, certain types of food-poisoning, and, what was very exciting, against certain forms of tuberculosis. None of these were sensitive to penicillin or the sulphonamides. It was then tried in a number of hospital cases with success, though the effect seemed to vary in different people. Doctors have proved that it can be used along with other methods of treatment to cure some forms of tuberculosis but that others are not responsive. Still, this is very encouraging, as up to this time there was no drug that could be used against any form of tuberculosis.

Thus the discovery of more chemical weapons or drugs to be used in the battle against disease goes on quietly but efficiently in research laboratories. No doubt you will read of other new discoveries in chemotherapy before long.

BLOOD TRANSFUSION. Through an accident or other cause a person may lose a great deal of blood, enough to lead to severe shock or death. By transfusing or transferring blood from a healthy person it is possible to replace some of the lost blood of the injured person and so save his life. It was only during the Second World War that blood transfusion was used successfully on a large scale to save the lives of thousands of injured people.

For several centuries men have tried to transfer blood from one human being into another. Sometimes they even transferred blood to human beings from animals' bodies. Usually the transfusion caused the death of the

receiver, and it was only in 1900 that the reason for this was discovered by Professor Karl Landsteiner of the Rockefeller Institute in the United States of America. It was found that there were four types of blood, known now as A, B, AB, and O types, and that not all these types of blood will mix. Thus an injured person whose blood is of the A group can receive blood from a person whose blood is group A or group O. Blood from a person of blood group B or AB would cause the injured person's blood to clot and result in his death. Other blood groups or types have since been discovered. With these discoveries it is now possible to transfuse blood safely and with great success, by carefully testing to find the blood group to which the injured person belongs.

(Fox Photos Ltd.)

A volunteer blood-donor

In the early days of blood transfusion the blood was transferred directly from the blood donor or giver to the injured person. Now it is usual to make use of "blood banks". These are places attached to hospitals where blood given by blood donors can be stored ready for any emergency. After testing to see what type of blood he has, a blood donor usually gives about a pint of blood at a time. This is treated with a chemical to prevent it from clotting and then it may be preserved for several days in bottles in the "blood bank" at a low temperature. Or the red blood cells may be extracted from it and then be stored, either in liquid form at low temperatures, or dried and stored in bottles. This dried plasma will keep for years and, when it is necessary to use it, all that the surgeon or nurse needs to do is to add sterilised water.

Blood transfusion is another powerful weapon in the hands of the doctor fighting the battle for health, and many who would have died from severe loss of blood due to an accident are being saved daily.

QUESTIONS TO ANSWER AND WORK TO DO

1. Name the body's own defences against disease and say how each works.
2. What very often leads to a weakening of the body's defences?
3. Put these names in the correct order according to the dates they lived, and say what part each played in the fight against disease: Louis Pasteur, Anthony van Leeuwenhoek, Robert Koch, John Hunter, Alexander Fleming, Robert Lister, William Thomas Morton, James Young Simpson, Wilhelm Rontgen, Paul Ehrlich.
4. What is the difference between vaccination, immunisation, and serum treatment?
5. How would you convince someone who is doubtful about the value of diphtheria immunisation?
6. What is the difference between an antiseptic and a disinfectant?
7. Make a list of antiseptics and a list of disinfectants.
8. What is the difference between a local anaesthetic and a general anaesthetic?
9. Compare a modern hospital with a hospital of a little over one hundred years ago.
10. What use is made of X-rays in medicine?
11. What is the value of mass radiography? What might be one of the results if mass radiography were generally used?
12. What is meant by chemotherapy?
13. Write an essay on modern chemotherapy.
14. Why was blood transfusion a failure when first used?

PROJECT WORK

1. Collect pictures and make a poster on "Famous Men in the Fight against DISEASE".
2. Design and make a set of posters that could be used in a campaign to encourage parents to have their children immunised against diphtheria.
3. Obtain from the local clinic and chemists specimen bottles, labels, and materials, and collect pictures to make a display on "Chemotherapy".
4. Make two posters: one to illustrate old methods, and one to show modern methods, of fighting disease.

CHAPTER SEVEN

THE FIGHT AGAINST DISEASE (2)

WHAT YOU YOURSELF CAN DO. In the last chapter we were largely concerned with the weapons used by physicans and surgeons to win the battle for health. This is very important work, but no matter how skilful the doctors and how powerful the weapons we give them to fight ill health, the battle for health cannot be won unless you yourself play an active part. No doubt from what you already know of biology you will be able to think of many things you must do to maintain your body in a sound state of health. We need mention only the most important. You need well-balanced meals providing you with the body-building, body-protecting, and energy-giving foods. You must get out into the sunshine and fresh air, playing active games, camping, and hiking. You must keep yourself clean; have regular baths and frequent changes of clothing. Particularly must you wash your hands before a meal and after you have been to the toilet. You should attend to any small cuts and bruises and not let them develop into infected sores. You should try to avoid getting your feet wet and catching a chill, so that your body resistance will not be weakened. If you do get a cold, see that you don't spread it to others by careless sneezing, spitting, and coughing: always carry a handkerchief.

THE FOLLY OF NOT GOING TO THE DOCTOR. Many people, as soon as they feel a pain, begin to take some medicine or pill which they have seen advertised or that their friends have perhaps told them about. You should beware of

this. Some of these patent pills and medicines may be helpful, but far too frequently they do not remove or attack the cause of the disease, but give only temporary relief. Since the person does not know what is really causing the pain, the pills or medicines may even make the trouble worse. After temporary relief from pain has been obtained the trouble may occur again later. In the meantime the micro-organisms causing the trouble will have increased in number and complete cure will be more difficult.

Vast sums of money (several millions of pounds a year in England alone) are spent on patent medicines and pills, especially on pills and medicines for "making the bowels work" or to prevent constipation. Usually these interfere with the work of the muscles of the intestines and make the trouble worse so that more and more pills have to be taken. This method does not remove the cause of constipation, which is probably due to wrong feeding. A far better and cheaper way of preventing constipation is to include in the diet apples, oats, bran, and vegetables.

If a person does feel ill it is far better for him to go to a doctor, who has been trained to find out the cause of the trouble and who has studied the methods of curing the sickness. The doctor will have a better chance if the patient goes to him early before a disease has developed. Though you do not want to run to a doctor every time you get an ordinary head-cold, you should always see him if there is anything unusual, e.g. if you have pains in the neck with your cold or a temperature. Correct living and correct eating are sounder ways to health than taking costly and often useless and possibly harmful pills and medicines.

HOW THE FIGHT IS GOING. Perhaps now you are wondering what has been the result of all these advances and new ideas

in medicine and surgery. Perhaps you are asking, "What progress has mankind made in the fight against disease and sickness?"

That much progress has been made is clear from the fact that we no longer suffer from the plagues which at one time frequently swept over this country killing large numbers of the population. In the fourteenth century the Black Death caused the death of nearly three-quarters of the population of England. We still may have epidemics of influenza and outbreaks of measles, but these are dealt with at once and prevented from becoming a serious menace to the community.

Another sign that we are gaining in the battle for a healthier people is the fact that more people can expect to

(*Picture Post Library*)

During the Great Plague, about 70,000 people died in London

live longer than was the case some years ago. Look at the figures in the table below:

EXPECTATION OF LIFE IN ENGLAND AND WALES

Year	For Boy Babies	For Girl Babies
1871	40·4 years	43·5 years
1901	45·9 years	49·8 years
1911	51·5 years	55·4 years
1931	58·7 years	62·9 years
1951	65·84 years	70·88 years
1954	67·58 years	73·05 years
1956	68·0 years	73·0 years
1957	68·0 years	74·0 years

From this table you will see that a baby boy born in 1871 could expect to live just over forty years. It does not mean that all the baby boys born in 1871 would probably live for forty years, but that if you took the length of life which all these babies lived, the average length of life was about forty years. You will see that this has gradually lengthened and that a baby boy born in 1954 could reasonably expect to live over sixty-five years. The same is true for girl babies. The main reason for this improvement is this. In 1871 disease was more widespread and there was a greater chance of a person being killed by these diseases before he reached thirty or forty years of age. Especially did far more babies fail to reach their first birthday. With all the modern methods of fighting disease and people being encouraged to live healthier lives, the killing diseases are gradually being overcome, and so any baby born now has a far greater chance of living to sixty or more years than in 1871.

Children's health has also improved greatly. A visit to a school, say, in 1901, would have revealed that quite a large number of the children were suffering from malnutrition, ringworm, heart disease, rheumatism, and

diseases of the lungs, throat, and nose. A visit to a school today would find fewer children with signs of malnutrition, and a much healthier race of children altogether. Fewer would be found to be suffering from the various diseases.

One of the most thrilling indications of success is the reduction in the infant mortality rate. For various reasons, such as diseases to which infants are especially liable, a number of babies die before they reach the age of one year. This is called infant mortality, and the number who die out of every thousand babies born alive is called the infant mortality rate. Thus, if out of every thousand babies born alive thirty die before they are one year old, we say the infant mortality rate is thirty. Now look at the Infant Mortality rate Table for England and Wales between 1871 and 1957.

INFANT MORTALITY RATE FOR ENGLAND AND WALES
1871 to 1957

Period	*Infant Mortality Rate* i.e. deaths of children in their first year of life
1871–80	149
1881–90	142
1891–1900	153
1901–10	128
1911–20	100
1921–30	72
1931–5	62
1936–40	55
1941–5	50
1946–50	36
1955	24·9
1956	23·7
1957	23·1

If you examine the figures carefully you will see that the position has improved very much, and that fewer babies die in their first year than was at one time the case. This is because mothers are being taught how to look after their babies better, and are receiving sound advice and help from child welfare and maternity clinics. But we must not be satisfied yet. More babies die in their first year of life in Scotland than in England and Wales, and more babies die in their first year of life in England and Wales than in Australia and New Zealand.

When we examine the figures showing the number of deaths of people of all ages from various diseases, we find that fewer people are being killed by scarlet fever, typhoid fever, measles, and diphtheria. The improvement has been a steady one, showing that through our increasing knowledge of these diseases and the use of modern methods of combating them we are gradually winning the fight against them.

Studying the figures for tuberculosis, we find that the number of people dying from this disease in England and Wales has been steadily reduced from 53,120 in 1911 to 6,493 in 1955. Tuberculosis we have already found to be a social disease due largely to overcrowding, poverty, malnutrition, and to drinking milk from tubercular cows. There is no doubt that improvements in social conditions—higher wages, better housing, and improvements in standards of nutrition—have done much to reduce the death-rate from tuberculosis.

Now, too, there are fewer deaths from tuberculosis because of improved methods of treatment and because the disease can be discovered in its early stages. Medical knowledge has recently advanced so rapidly that soon we may be able to say that the fight against tuberculosis as a killing disease has been won

as decisively as the fight against typhoid fever or diphtheria.

But, unfortunately, there are some diseases against which we do not seem to be gaining or where progress seems to be very slow indeed. Among these diseases are cancer, heart diseases, influenza, and the common cold. Respiratory diseases, that is, diseases of the breathing system apart from tuberculosis, are also responsible for a high death-rate.

But we must be careful in studying such figures. Twenty or more years ago it was more difficult to diagnose or say what a person was suffering from and very often a person was only discovered to be suffering from a disease when in its late stages. Now, with modern methods of diagnosing, we can be more sure in saying what a person is suffering from, and discover the disease in its very early stages. Because of this, you will realise that some of the figures for recent years are higher, as they include many who would not have been included in the figures of twenty or more years ago.

A great deal of research, however, still needs to be done in those diseases that have increased instead of falling, in discovering the causes, methods of prevention, and new ways of treatment.

ROAD ACCIDENTS. Now let us leave the diseases against which we are constantly fighting and turn to another grave problem—road accidents. Look at the table showing the road accidents in Great Britain during a number of years. Most of the accidents were caused in one of these ways:

1. By pedestrians not paying attention to the traffic, and dashing into the road without due care.
2. By people crossing the road behind a stationary vehicle.
3. By children playing in the road.

(By courtesy of Sir L. H. Keay, O.B.E., M.Arch., Director of Housing, Liverpool)

The old and the new. Compare them. What improvements do you note? What may be one result of these improvements? Since this photograph was taken the old buildings have been pulled down

ROAD ACCIDENTS IN GREAT BRITAIN

Year	*Persons killed*	*Persons injured*	*Child Pedestrians and Pedal Cyclists* Killed	Injured
1938	6,648	226,711	1,075	41,160
1953	5,090	221,680	728	36,277
1954	5,010	233,271	616	36,085
1955	5,526	262,396	702	39,357

Four out of every five road accidents could easily have been avoided.

What can be done to reduce this accident rate? Obviously, the first way is for you yourself to use the roads with great care. Think before you cross a road, and make sure it is quite safe to cross: go on thinking all the time you are crossing it. Use pedestrian crossings. Assist young ones to cross and teach them the rules of safety-first. If you ride a cycle see that it is in good order, and ride it with care, giving all the necessary signals. It is a great temptation to do a bit of trick cycling, but don't do it if it means danger to your life and other people's lives. The Highway Code contains all the advice and instruction you need to know, whether you are a pedestrian or cyclist. You should read it, and at intervals read it again to make sure you know how to use the highway correctly. Because you learned the kerb drill in the infant and junior schools does not mean that you do not need to bother about it as you grow up. You do. Accidents occur at all ages.

ACCIDENTS IN THE HOME. Many avoidable accidents happen in the home, especially to very young children and old people. Every year more children in England and Wales die as a result of accidents in the home than from any single infectious disease.

In the home, as on the road, carelessness on your part may easily cause accidents or death to others. It would be rather stupid to win the long and difficult fight against disease just to find out that more and more people were throwing away their health and lives through silly accidents they could avoid.

(By courtesy of Ro.S.P.A.)

How does this poster help to reduce road accidents?

(By courtesy of Ro.S.P.A.)

How do these posters help to reduce accidents in the home?

WHAT DO YOU KNOW?

1. Make a list of the things you should do to maintain your body in good health.
2. What silly things are done by people which may affect their own health or the health of other people?
3. Describe two advertisements for drugs you have seen, and say what the advertisers claim these drugs will do. Can you believe all these posters say?
4. Make a list of the diseases against which we are making progress, and another of the diseases against which we are not making progress or very little progress.
5. Make a graph from the Infant Mortality Rate Table on page 141.
6. What is meant by a social disease? What diseases would you consider to be social diseases?
7. A woman preparing meals in a café kitchen continues her work without washing her hands after going to the toilet, while the waitress wipes the table with a dirty cloth. In what way are these people behaving unsocially?
8. From your local police office obtain the figures for road accidents and make a chart and graph of them.

9. How are most road accidents caused?
10. What would you teach a younger brother or sister about the rules of Road Safety?
11. State three ways in which accidents in the home can be caused.
12. Think of what precautions you could take to avoid accidents in *your* home.

PROJECT WORK

1. Make a display entitled "THE BATTLE FOR HEALTH", using posters, graphs, photographs, etc., to show:
   - *a.* Where we are winning the battle.
   - *b.* Where progress is slow.
   - *c.* How the battle goes in your own neighbourhood. (For this you will need the assistance of your local health services, and the Medical Officer's reports.)
   - *d.* Where further progress can be made.
   - *e.* What *you* can do.
2. Make a similar display entitled "NO ACCIDENTS IN OUR HOME".

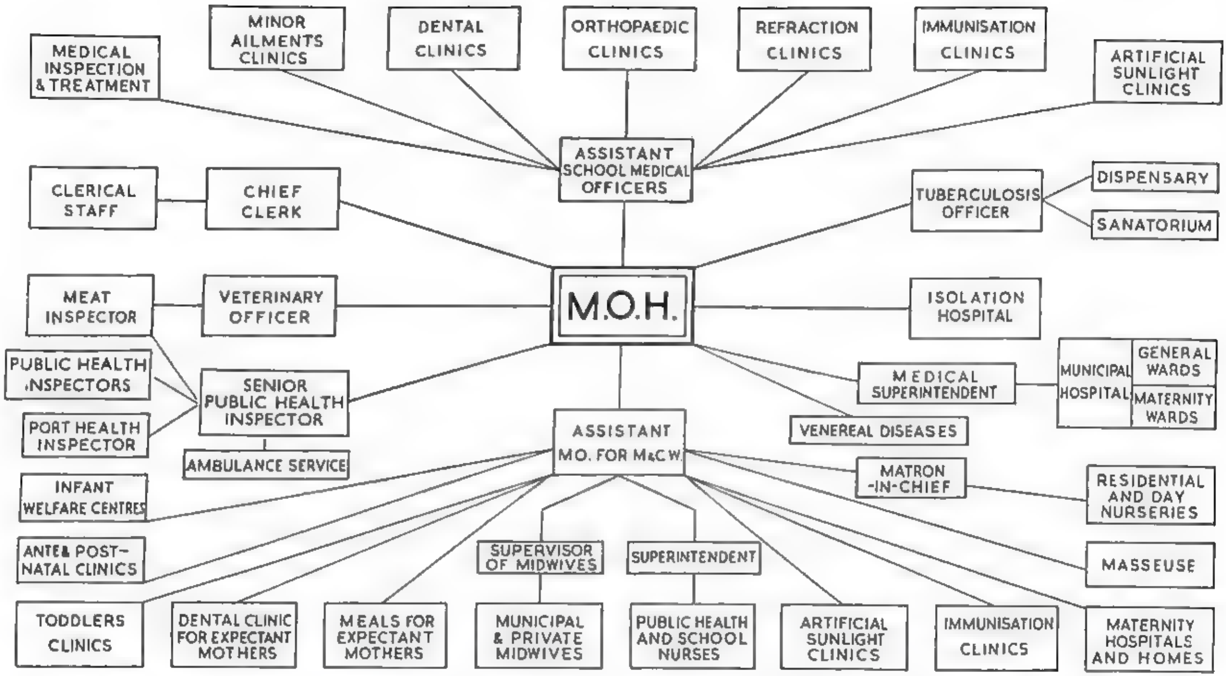
CHAPTER EIGHT

HEALTH AND THE COMMUNITY

THE fight against disease is not only of importance to each of us; it is important to the community in which we live and to the nation of which we are citizens. Sickness usually means loss of working hours, loss of wages, and payment for medical advice and care. It has been estimated that every year in Great Britain alone several million working hours are lost through sickness; the money spent on the care of the sick and health services amounts to over £500,000,000 every year.

The health of England and Wales is the concern of the *Ministry of Health*, at the head of which is the Minister of Health. The health of the communities, districts, or towns into which the nation is divided is the concern of the *Local Councils*. Each county and county borough has its Health Department and *Medical Officer of Health*, and all are under the indirect control of the Ministry of Health. The work of the Ministry of Health is to see that everything possible is done to improve the health of the nation. It collects facts about the health of the nation and publishes these in a report every year. It holds inquiries into outbreaks of disease and gives advice about dealing with them. It introduces into Parliament new laws and regulations about health which become *Public Health Acts* when Parliament passes them.

Other Government Departments are also concerned with health. There is a Department of Health for Scotland, under the Secretary of State for Scotland. The Ministry of Education too is concerned with the physical



(By courtesy of Preston Municipal Council)

Organization of a Public Health Department of a Council

as well as the mental health of the children of the nation.

In the smaller communities the Medical Officer of Health looks after the health of the people in them and advises the local council on the steps to be taken to maintain and improve the health of the community. We must now see what steps are taken to make the nation healthier.

One of the most important Acts introduced by the Ministry of Health is that which makes certain infectious diseases notifiable. Some *notifiable infectious diseases* are diphtheria, typhoid, scarlet fever, smallpox, and tuberculosis. As soon as anyone is found to be suffering from one of these infectious diseases, the relatives of the sick person, or the doctor in charge of the case, must notify the Medical Officer of the district at once. By this a great deal can be done to prevent the disease from spreading. Arrangements are then made to remove the person to a fever hospital or *isolation hospital*, where he or she can be isolated from other people. At the same time the doctor and the Medical Officer will examine and keep under observation any people who have been in contact with the case, and they, too, will be isolated if they catch the disease. The house where the patient has been living, the clothing, furniture, and other articles which he has been using will be *fumigated*. Sometimes milder, though none the less dangerous, epidemics such as measles, influenza, and mumps are made notifiable, so that all possible help can be given in checking the disease.

More important still are the efforts made by the Ministry of Health and the local councils to prevent diseases from starting. Local councils are given power by law to appoint *public health inspectors* to inspect the food sold in shops and stored in warehouses. If the food is not clean or is sold under dirty conditions, or if it is not up to certain

fixed standards, the people who sell it can be prosecuted. These public health inspectors pay particular attention to milk, for it is readily infected with bacteria. The public health inspectors also visit places where foods such as bread, sausage, potted and pressed meats and fish, and ice-cream are made, to see that they are clean and sanitary. Any food found not up to standard must be destroyed.

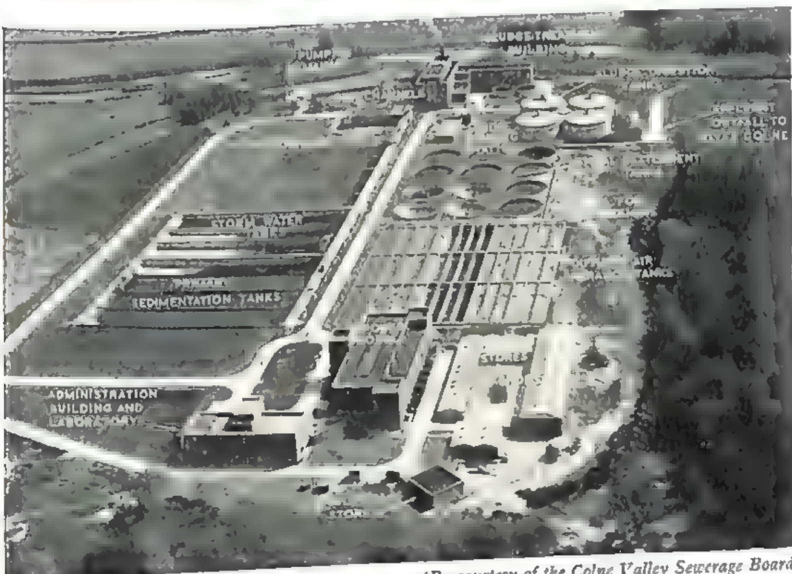
Councils take great care that their water supply is not polluted by drainage water. They also see to the removal and disposal of sewage and refuse. Most modern houses now have bins for the refuse in place of middens in which the refuse lay open to the flies. Also, the old-fashioned bucket privies of old houses are being replaced by water-flushing lavatories.

One of the greatest efforts being made to improve the nation's health is the *clearance of slums*. Slum houses with narrow windows, small or no back yards, open middens, bucket privies, one communal tap for water supply, large numbers of people living huddled together in one or two dark dismal rooms, and narrow streets into which no fresh air or sunlight can penetrate, have always been a great source of bad health and a breeding ground for disease. Many progressive towns are replacing these by healthier and scientifically planned flats and council houses with gardens and play spaces for the children. More attention is being paid to town-planning, so that in and round about the town there will be wide roads, parks, recreation grounds, and other open spaces. Some of our large cities are buying land on the outskirts of the city and forming a "green belt" of open spaces around the city. These parks, playing fields, and open spaces are the "lungs" of a city.

But the clearance of the slums is not just a matter of removing people from slum houses to a housing estate or flats where the conditions for living are much better. It

(*By courtesy of the Metropolitan Water Board*)

Filter-beds of London's water supply



(*By courtesy of the Colne Valley Sewerage Board*)

Sewage disposal works

often leads to other problems and difficulties. This is well illustrated by what happened in one area. People from an overcrowded slum area were rehoused in a new housing estate where the houses were sensibly designed and well-built, and equipped with all modern sanitation, and good bathroom, kitchen and larder, and wash boiler. It was expected that as a result of the rehousing, the health of the people would improve, but it did not. Indeed, taking the mortality rate as a guide, it was much worse. From a mortality rate in the slum conditions of 23 per 1,000 it went up on the new housing estate to 33 per 1,000. This was a very serious matter. The Medical Officer of Health gave the following as the reason for it. In the slum area, the rent per family per week was 4*s*. 8*d*. On the housing estate the rent was 9*s*. per family per week. Thus an extra 4*s*. 4*d*. a week had to be paid in rent, which meant

(Aerofilms Library)

A New Town at Stevenage

that there was less money every week to be spent on food and clothing, and this resulted in a lowering of the health standard.

(Fox Photos Ltd.)

Is this removal to a new house on a new estate going to mean fresh problems for the family to face? Is it going to affect their standard of nutrition and health?

Indeed, the rehousing of people in this manner involves all sorts of problems. A family may have to buy new or extra furniture and furnishings for the new home, which may mean another reduction in the money spent on food and clothing. Quite frequently the housing estate is on the outskirts of the town, and very likely the people will now be farther from their place of work. This involves further expense in bus or train fares, or it may mean queueing for

buses or walking or cycling, frequently in bad weather. This again may affect people's health for the worse. Thus, rehousing people from overcrowded slum areas is not as simple as it sounds.

We have already seen that some diseases are caused or aggravated by the conditions under which people work. The dust floating about in the air of textile mills, the steel dust formed in grinding steel, the silica dust produced in coal mines and stone-cutting, and the fine paint particles in paint-spraying often cause lung diseases amongst the workers. To reduce this trouble Parliament has passed several Acts known as *Workshop and Factory Acts* governing the conditions under which people work. *Factory inspectors* appointed by the Home Office visit factories to see that the Acts are being carried out. In some forms of work, such as paint-spraying, the workers are compelled to wear masks to prevent paint getting into their throat and lungs. Some progressive factories provide baths and playing fields for their workers and form a welfare centre where the health of the factory hands can be attended to.

Though we can now be sure of having a good clean supply of water and food, little has been done so far to prevent the air we breathe being polluted. From the coal burnt in hundreds of thousands of homes and factories vast quantities of harmful gases and injurious chemicals and soot pour into the atmosphere. Many of the respiratory diseases are due to the smoke-polluted air which people have to breathe. Also, smoke in the air cuts down the amount of sunshine. Laws have been passed restricting to some extent the quantities of fumes which can be turned out from the furnaces of a factory, and some "smokeless zones" have now been established, but much more needs to be done.

INSURANCE AND HEALTH SERVICES. One of the greatest difficulties in the fight against disease used to be the inability of poor people to pay for medical attention. This was made worse by the fact that time off work through sickness usually led to loss of wages. To meet these difficulties the *National Health Insurance Act* was passed by Parliament in 1911. By this Act all persons over sixteen years of age earning less than £250 a year had to be insured. Since that time various extensions have been made, and then in 1948 two schemes were brought into effect which covered the whole nation.

One scheme was *National Insurance*. Everyone living in Great Britain benefits and pays for it. Weekly contributions are paid by all workers and by their employers, and the rest comes out of taxes collected by the Government. For example, an employed man over eighteen years of age pays 11*s*. 8*d*. a week, while his employer pays 9*s*. 8*d*. per week for the worker. An employed woman over eighteen years of age pays 9*s*. 8*d*. a week and her employer 8*s*. 4*d*. An employed young man under eighteen years of age pays 7*s*. 8*d*. a week and a young woman 6*s*. 4*d*. a week. The payment is made by National Insurance Stamps bought at a post office and stuck on a National Insurance Card.

How does National Insurance affect health? In this way. If the wage-earner in a family ceases to earn money because he is sick or because he can't get employment, both he and all his family may be unable to buy good food and warm clothes. Also they will worry. Now, to worry is one of the quickest ways of running down your health. By National Insurance everybody is assured of getting some income if they are sick or unemployed or when they are too old to work. Also, mothers get maternity benefits before and after each baby is born.

The other scheme was the *National Health Service*, which provides all men, women, and children with free

(Fox Photos Ltd.)

Ten tiny tots drinking their milk in a Nursery school

(Camera Press Ltd.)

A modern, well-ventilated ward in a general hospital

(Crown Copyright Reserved)

Mothers bringing their babies to a Child Welfare Clinic

medical and hospital advice and treatment. Up to the age of 21 dental treatment is free, and all children at school can get proper glasses free. After this both dental and optical examinations are still quite free, though some contribution (well below cost) must be paid for treatment of teeth and eyes. The National Health Service has done much to raise the standard of health of the people.

In addition to the Insurance Benefits, and Health Services, a scheme of *Family Allowances* was begun in August 1946. By this, parents receive 8*s*. per week for the second child and 10*s*. per week for each subsequent child in their family who is at school or apprenticed.

The welfare services do much to help in the fight against disease. In the "Welfare State" the community does everything it can to help the individual to keep fit and well.

(Fox Photos Ltd.)

Young artists in an Infant school

INTERNATIONAL ORGANIZATIONS. Since the beginning of the present century rapidly increasing trade and quicker methods of travel have brought the nations close together, and what happens in one country, sooner or later, has some effect on other nations. For example, a breakdown of the steel industry in the United States of America is soon felt in countries depending on the U.S.A. for steel supplies, while a poor wheat harvest in the wheat-growing countries results in a world-wide food shortage. Similarly in health matters. What happens in one country may have some effect on the health of other nations. Disease is not stopped by frontiers or political differences, so nations have met together to form international organizations for promoting good health in all countries and for preventing diseases spreading.

INTERNATIONAL SANITARY CONVENTIONS. Amongst the earliest international health organizations were those set up to control the spread of epidemics from one country to another. By various conventions or agreements many nations agreed to provide help if an epidemic occurred in any country, and to insist that all people in a disease-infested area should be inoculated. They also drew up a set of rules so that they would be sure that ships or aeroplanes coming from an infected area would be disinfected and that the passengers would not carry diseases into other countries.

UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION (FAO). With the Second World War the food position became much worse. Large areas used for growing food were ruined in the fighting, and millions of men were engaged in war work instead of farming. There was just not enough food being produced for everyone in the world to be properly fed.

So the United Nations set up the Food and Agriculture Organization, not only to deal with this emergency, but also to raise the standard of nutrition in all countries.

But the problem of food and nutrition cannot be solved easily or quickly. The population of the world is increasing at the rate of about twenty million a year and all these people need food. Producing this extra food is not easy, as large areas of land are becoming less fertile because of bad farming which has resulted in over-cropping of the land, and because of soil erosion.

The question of the world's food supply is indeed an extremely serious one, and will need careful and united attention from all nations.

WORLD HEALTH ORGANIZATION (WHO). The United Nations also set up a special body which was to carry on and expand the work begun by the League of Nations Health Organization, to do all that was possible to raise the standard of living amongst the peoples of member nations and to deal with problems of international health. In 1946 representatives and health experts of sixty-one nations met together. Here is part of the Constitution they drew up:

> Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.
>
> The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief or economic or social condition. The health of all peoples is fundamental to the attainment of peace and security and is dependant upon the fullest co-operation of individuals and States.
>
> The achievement of any State in the promotion and protection of health is of value to all. Unequal development in different countries in the promotion of health and control of disease, especially communicable disease, is a common danger. Healthy development of the child is of basic importance; the ability to live harmoniously in a changing total environment is essential to such development.

The extension to all peoples of the benefits of medical, psychological and related knowledge is essential to the fullest attainment of health. Informed opinion and active co-operation on the part of the public are of the utmost importance in the improvement of the health of the people. Governments have a responsibility for the health of their peoples which can be fulfilled only by the provision of adequate health and social measures.

Amongst the tasks which the World Health Organization has set out to do are the following:

To act as the directing and co-ordinating authority on international health work.

To assist Governments, upon request, in strengthening health services.

To stimulate and advance work to eradicate epidemic, endemic and other diseases.

To promote, in co-operation with other specialised agencies where necessary, the improvement of nutrition, housing, sanitation, recreation, economic or working conditions, and other aspects of environmental hygiene.

To promote co-operation among scientific and professional groups which contribute to the advancement of health.

To promote maternal and child health and welfare and to foster the ability to live harmoniously in a changing total environment.

To foster activities in the field of mental health, especially those affecting the harmony of human relations.

To promote and conduct research in the field of health.

To promote improved standards of teaching and training of health workers and the medical and related professions.

To study and report on administrative and social techniques affecting public health and medical care from preventive and curative points of view, including hospital services and social security. To provide information, counsel, and assistance in the field of health.

To assist in developing an informed public opinion among all peoples on matters of health.

To establish and revise as necessary international nomenclatures of diseases, of causes of death and public health practices.

To standardise diagnostic procedures as necessary.

To develop, establish and promote international standards with respect to food, biological, pharmaceutical and similar products.

The World Health Organization is not meant to be the only body tackling the tremendous problems of ill health throughout the world. But it is a central body that can ask for help from experts from every country. It sets out to consider health in all its aspects. It seeks to promote good health in all nations, not only by providing for better methods of diagnosing and treating sickness, and by sharing new discoveries in the field of health, but by suggesting improvements in nutrition, housing, sanitation, recreation, and healthy working conditions, and by giving help (such as by lending doctors and specialists) to those nations which are faced with epidemics and other problems which threaten their standard of living and health.

(Photo Unations)

The World Health Assembly in session

WORK TO DO

1. What effect has sickness on the work of a nation?
2. What has to be done when someone is found to be suffering from an infectious disease?
3. What precautions are taken to ensure a good supply of food in your town or village?
4. Give any examples you know of bad housing conditions.
5. Describe any slum clearance scheme or housing scheme which you think is an improvement on the older forms.
6. Say where the following are in your town or village: School Clinic, School Dental Clinic, Maternity and Ante-natal Clinic, Infant Welfare Centre, Public Health Department.
7. In what ways does rehousing sometimes have an effect on the nutrition of the people concerned?
8. From books on public health and your local Medical Officer's reports, find out the jobs that a public health inspector has to do.
9. What is National Insurance and what is its value to the nation's health? Does the National Insurance contribution paid by the *worker* cover the whole cost?
10. John, aged twenty, has been at work for five years and has paid his National Insurance contributions. He is suddenly taken ill. How will he benefit from the scheme, and what must he do to obtain the benefits?
11. Mrs. Jones has three young children, Mary aged 2 years, Bill aged 4½ years, and Ken aged 16½ years. Ken is working with his father at an engineering works. Mrs. Jones is expecting another baby soon. What benefits from the National Insurance and Family Allowances schemes does she receive for the children, and for the new baby, before and after it is born?
12. What is meant by smoke abatement and what is its importance? What effect has a smoky atmosphere on the health of a nation?
13. Describe what is done in your school to keep the children healthy.
14. What is being done in your town or village to make its inhabitants fitter?
15. What is a problem family? What kind of a person is most likely to be successful in helping such a family?
16. What is the problem that must be solved by the United Nations Food and Agricultural Organization?

PROJECT WORK

1. *Battle for Health in Your Town.*
   a. Invite the following people to school to speak on their work: The Chairman of the Local Health Committee, the Medical Officer of Health, Chief Public Health Inspector, Senior Health Visitor, representative from the Borough Engineer's Department, a bin man. Make notes of their talks and write a report.
   b. Obtain permission to visit:
      1. The local clinics.
      2. The local Health Office and Borough Engineer's yard to see the work done there.
      3. The local sewage and refuse disposal works.
      4. A nursery.

      This work may be done by the whole class or, if it is possible for the class to divide into groups of two or three, then each group makes one of the above visits and writes a report for the others. In addition it may be possible for some groups to go with the public health inspectors on some of their jobs, and others could visit, if possible, the laboratory where food samples from the town are analysed. The reports of each group could be bound to form a General Report on the Health Services of the Town.
   c. Obtain a map of your town and paste it on a sheet of cardboard, leaving a wide border all round. Take photographs of the various health centres and the public health inspectors, etc., doing their work. Stick these photographs on the border round the map. From each photograph run a coloured cord to the map where the particular health centre is.
   d. If there is a photographic society in the school, get them to make a film-strip of the above photographs.
2. Make a series of posters on the National Health Services to show: The benefits received and how they are paid for.
3. Make a report to the class on the work of the World Health Organization last year. Ask your teacher to write to the Division of Public Information, World Health Organization, Copenhagen, for a copy of *W.H.O. Newsletter* in English. This is published monthly and is free. In your school library read *Mankind Against the Killers*, by James Hemming.

CHAPTER NINE

FIGHTING ANIMAL AND PLANT DISEASES

EARLIER in this book we have seen the urgent need for producing more food to feed the world's population, while earlier still we learned that animals and plants are liable to suffer from various diseases. Obviously, it is vital that we should do all we can to protect the animals and plants from the diseases which may attack them, or to cure them if they fall victims to disease. Our job now is to find how we battle against plant and animal diseases.

ANIMAL DISEASES. The methods used to fight animal diseases are very like those used to fight disease in man. For many years veterinary surgeons have used medicines and drugs, or, where necessary, surgical treatment to cure sickness in animals. Now they can make use of such recent discoveries as penicillin and the sulphonamide drugs. For example, penicillin can be injected in cows to cure a disease which affects their udders. A little sulphapyridine added to the sugar and syrup fed to bees cures a disease which kills off many bees in a hive.

Inoculation, too, is used in the treatment of certain animal diseases. For example, if the weather in spring is inclined to be cold and damp, new-born lambs are liable to suffer from lamb dysentery which kills off large numbers. A lamb drinks milk from its mother, then from the ground it may pick up the micro-organisms which cause lamb dysentery. These pass along the food canal of the lamb, where they find the milk drunk by the lamb excellent for

growing in. They therefore increase rapidly in numbers and within forty-eight hours the lamb dies. At one time little could be done about it, but now we inoculate the lambs against the disease. In the biological laboratories where serums are produced, horses are inoculated with lamb dysentery. In the horse's body anti-bodies are produced and these are drawn off in the form of serum. This is purified and then sold to shepherds for inoculation into new-born lambs.

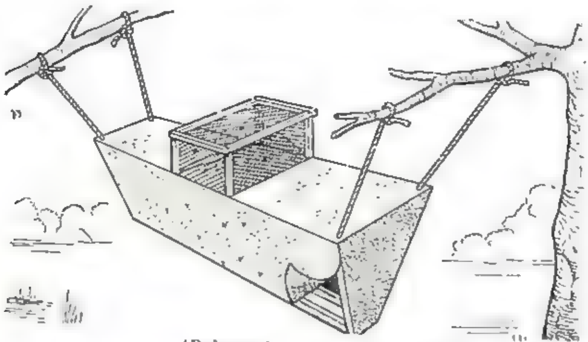
You may know that if a person is suffering from scarlet fever or diphtheria he will be sent to an isolation hospital to prevent the sickness spreading to other people. Though we do not have isolation hospitals for animals, we do use a form of isolation to prevent infectious disease spreading to other animals. Take foot-and-mouth disease, for example. This is a disease caused by a virus which attacks cattle, sheep, pigs, and other animals. The virus can spread from infected animals to healthy animals by the tiny drops of moisture in the breath. It can also be spread by the excreta from infected animals, or by their drinking-troughs. If, then, healthy cattle walk across a field where infected cattle have been, it is almost certain they will pick up the virus on their feet and mouth, and spread it to any other field. Farmhands even, walking across the infected field, can spread it to other fields, or they can spread it from their hands if they have had to handle infected animals.

If an outbreak occurs in a certain district, that district is scheduled as an infected area. No animals are allowed to enter or come out of the area until the outbreak is over. Any person who has to enter the area must, on coming out, walk through a shallow trench of disinfectant or take other precautions to prevent the spread of the virus. Since we have not found any cure for foot-and-mouth disease, infected animals are killed and then destroyed by burning.

Every year large numbers of cattle have to be destroyed because of foot-and-mouth disease. Some people think the virus is spread by birds from one district to another. It has been observed frequently that an outbreak in Northern Europe and Germany is followed by an outbreak in Britain. It has been suggested that starlings which migrate from Northern Europe and Germany to Britain are responsible for this. This, however, has not yet been proved definitely.

One other method of fighting animal diseases must be referred to, and that is the destruction of insects which are the means of spreading animal diseases. They do not themselves spread the actual disease, but they do spread the viruses, bacteria, and the protozoa which cause the diseases. One of the most serious diseases in Africa, killing off large numbers of cattle, is caused by a micro-organism called a trypanosome, carried by the tsetse fly. The tsetse fly feeds on the blood of cattle. If it feeds on the blood of an infected cow it will pick up large numbers of trypanosomes. The tsetse fly will not itself be affected, but when feeding on a healthy cow, it first pierces the skin, injects saliva into the wound, and then sucks the blood. It is the saliva which contains the trypanosomes and thus another cow is infected. So serious is the menace of the tsetse fly that huge areas of Africa which could be used for rearing large herds of cattle are simply left as useless bushland. Indeed, it is one of the main causes of poverty and malnutrition amongst many African native tribes, since they suffer severe losses in their cattle.

The most obvious way of attacking this disease is by destroying the tsetse fly which carries the trypanosomes. Various methods are used, amongst which are the use of tsetse fly traps, the clearing of forests and bushes which the tsetse fly seems to prefer, and the spraying of insecticides such as Gammexane and DDT.



(*Redrawn from Skaife: The Outdoor World, Book 4*)

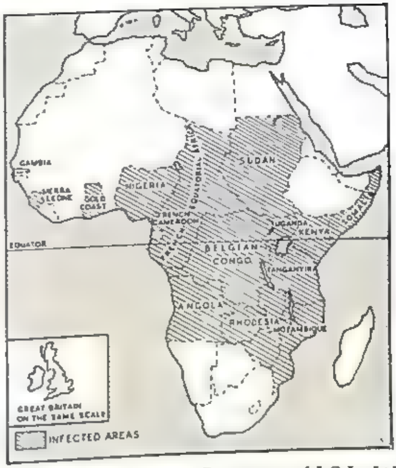
The Harris tsetse fly trap. About the size of a donkey's body, it consists of sacking stretched over a wooden frame. The flies mistake it for an animal and try to feed on it.

(*From Skaife: The Outdoor World, Book 4*)

This heap contains over two million tsetse flies caught in one month in a river valley in Zululand by Harris tsetse fly traps

The most recent and what will probably be the most successful weapon against the disease in cattle spread by the tsetse fly is the new drug, antrycide, which can be injected to cure or to immunise cattle.

The prevention and cure of disease in cattle and domestic animals is really only in its early stages. We have still much to learn.



(By courtesy of I.C.I., Ltd.)

Countries in which the tsetse fly is deadly to cattle

(By courtesy of I.C.I., Ltd.)

Dr. D. G. Davey, one of the scientists responsible for the discovery of "antrycide". What other recent discovery did he make? Who were his co-workers?

PLANT DISEASES. We have already seen in Chapter Five that plants can be attacked by bacteria, viruses, and fungi, and that they suffer from deficiency diseases if there is something lacking in their food supply. By far the greater number of plant diseases is caused by fungi.

One of the most widely used methods of attack against plant disease is by spraying the plants or treating the soil in which they are growing with chemicals to destroy the organisms causing the diseases. One of the most widely used sprays against fungi on garden and farm crops is Bordeaux mixture (a solution of 1 lb. of powdered copper sulphate and $1\frac{1}{4}$ lb. of hydrated lime in 10 gallons of water, made just before use). A disease common amongst the cabbage family of plants is club root, caused by a fungus in the soil which enters the roots. Club root can be checked if lime is spread on the land.

Another method of preventing fungus disease is by coating the seeds, before sowing, with chemicals called "seed protectants". In this way the seeds are protected from organisms which may attack them in the soil. It has been particularly successful against the fungi which cause "damping off" in seedlings. The seedlings infected by the fungi in the soil seem to rot just where they appear out of the soil and die off.

Amongst the chemicals which may find greater use in the treatment of plant diseases are drugs like penicillin. Already in the case of a disease common in many trees caused by bacteria, treatment with penicillin has proved very effective. Indeed, research work being carried out leads us to believe that drugs, like penicillin, obtained from moulds and other fungi, may prove useful in fighting diseases of plants caused by other kinds of fungi.

I expect you are all acquainted with the blackfly on beans and the greenfly on roses. These insects belong to the

insect group called "aphides". These not only do a great deal of damage to the leaves of plants, but also carry some of the virus diseases which attack plants, e.g. potato leaf-roll, tomato mosaic disease, lettuce mosaic disease, tobacco mosaic, beet mosaic, and sugar-beet yellows.

When an aphis feeds on a plant, it pierces the leaf, injects saliva which helps to set free juices in the leaf, and then begins to suck these juices. If this plant is suffering from a virus disease, some of the virus will pass with the juices into the aphis. The aphis will not be affected by the virus, but it will now for the rest of its life be able to transmit the virus into any plant on which it feeds, and thus spread the disease. The best method of attack here would be to get rid of the aphides, but this is very difficult. The most common method of dealing with it is that of growing disease-free seedlings well away from any infected crops.

(By courtesy of the Rothamsted Experimental Station)

Common Blight on potato plants

One interesting point is worth noting about aphides and virus disease in plants. A wise farmer or gardener wishing to set potatoes will buy Scotch "seed" potatoes rather than English "seed" potatoes, because Scotch "seed" potatoes seem to be less liable to certain diseases. The reason is

believed to be this. Those aphides with wings can fly fairly long distances, and they frequently do so when there is very little wind and it is warm. In England these conditions often occur, so that aphides very often fly over large areas. If the aphides are carrying virus, then clearly there is great risk of potatoes over these large areas being infected. The "seed" potatoes from these infected plants will also be infected and thus be of poor quality for use as sets. In Scotland there is less chance of the weather being still and warm, and therefore there is less opportunity for virus-carrying aphides to migrate there. Thus large areas of Scotland where potatoes are grown are free from virus infection, and the "seed" potatoes from such plants are of high quality and less subject to virus disease.

One very important point to remember about plant virus diseases is that they are very infectious. Thus a person handling a virus-infected tomato plant can transmit the virus by his hands to a healthy plant. Viruses are also very persistent. Even if a plant is dried any virus in it will remain active. The virus which causes mosaic disease in tobacco plants will persist even when the leaves have been made into tobacco. A gardener handling such tobacco with his hands, and then going to work amongst tomato plants, will spread the virus to the tomato plants. To prevent this disease getting amongst tomato plants, the gardener should not smoke or chew tobacco where the plants are growing. Workers who smoke should wash their hands very thoroughly in hot water and soap before handling tomato or tobacco plants.

Careful cultivation of land will often do much to produce healthy crops and get rid of disease. It will help to aerate the soil and prevent water-logging in heavy soils; conditions which often lead to unhealthy plants. Careful

cultivation will also result in the eradication of weeds and old plant remains which are often the sources of infection and which harbour the insects that spread virus and fungus diseases.

In some plant diseases the organisms causing the disease may remain in the soil after diseased plants have been removed. If the same crop is grown on this land the following year, at once it will become infected. This is what happens in the case of wart disease in potatoes. This disease is caused by a fungus which produces warty growths on the potatoes. These warty growths turn into a black soft mess from which the spores of the fungus enter the soil, and so it becomes, and may remain, infected for a number of years. Any potatoes grown there will at once be attacked by the disease. Treatment to get rid of the fungus causing the disease is very difficult, but steps

The fungus spores—highly magnified—that cause Common Blight

have been taken to isolate the disease. By law, any outbreak of wart disease must be reported at once and all potatoes from an infected field must be burnt. No infected potatoes may be sold for any purpose and no potatoes, except those kinds which are immune to the disease, grown on the land.

Dusting to prevent Common Blight

This brings us to another method of fighting plant diseases. By carefully planned experiments, biologists have been able to produce plants which are immune to certain diseases. For example, varieties of potatoes have been produced which are immune to wart disease and can be grown on infected land. Whenever a new type of potato is produced it is first tested to see if it is immune to wart disease. Similarly, there are types of cabbage, cauliflower, and Brussels sprouts which are immune to club root disease.

Another method used in fighting plant diseases is that of soil sterilisation. This is done by means of steam or chemicals, but usually only with small quantities of soil or with soil in a greenhouse. In steam sterilisation, steam from a boiler is forced along pipes buried in the soil to be treated. The steam escapes through small holes in the pipes and passes through the soil. This heats the soil and destroys any disease organisms in it.

The chemical most commonly used for soil sterilisation is formaldehyde or "formalin". The soil to be treated is spread out on a stone floor to a depth of six to twelve inches. A solution of one part of formalin in forty-nine parts of water is then watered from a watering-can (2 gallons to 1 cwt. of soil) until the soil is saturated. After that, the area is covered with sacks for two days, then uncovered and turned over until the smell of formaldehyde has disappeared. After lying for about five weeks the soil can be used.

Soil sterilisation not only helps to destroy harmful organisms, but also kills any weeds that may be in the soil and improves its fertility.

Finally, we must consider deficiency diseases in plants. As with man and animals, plants require certain foodstuffs for healthy growth. If some particular foodstuff is missing, the plant may suffer from deficiency disease of some kind. A deficiency of potash in broad beans causes stunted growth, and scorching of the leaves. In cabbages it causes scorching of the leaves and poor "hearts". If the mineral boron is lacking from the soil where cauliflowers are growing, then they will not form good, firm, white heads. Heart rot, a disease often seen in sugar beet, is also caused by boron deficiency.

The best method of fighting the battle here is to put into the soil the mineral that is lacking. But this has to be

(By courtesy of the Rothamsted Experimental Station)

The potatoes on the left of the post were grown after the soil had been given a dressing of potash; those on the right had no potash

done carefully, since too much in some cases may do harm. Borax, which contains boron, is used to make up for the deficiency of boron in the soil, and potassium chloride or other potassium salt is used for potash deficiency.

Thus the fight against animal and plant diseases goes on. It is work of vital social importance, since by reducing the loss of plant harvests and animals due to disease, much will be done to meet the problem of the world's food supply. More and more, biologists and other scientists are busy at work studying plant and animal diseases, and slowly we are discovering new methods of keeping plants and animals free from disease or of controlling plant and animal diseases when an outbreak occurs.

WORK TO DO

1. Why is the fight against plant and animal diseases a matter of social importance?
2. What discoveries in the fight against disease in man are likely to be of use in the fight against animal and plant diseases?
3. Give an account of "foot-and-mouth disease" and the steps taken to control it.
4. Write a short essay on "The spread of disease by insects amongst animals and plants".
5. How are virus diseases in plants spread?
6. From books on gardening, find what you can about wart disease in potatoes, and write a short paper on it to read to the class.
7. What precautions must be taken in handling tomato plants?
8. Collect information on soil sterilisation from gardening books and pamphlets issued by the Ministry of Agriculture, Fisheries and Food, and write a paper on it.
9. What is a deficiency disease? Name some deficiency diseases occurring in plants, and explain how they may be dealt with.

PROJECT WORK

1. Collect leaflets dealing with some common plant diseases. Make a series of posters of these.
2. Make a poster showing a variety of ways in which animals get disease. Do the same for plants.
3. Take three animal diseases and make posters to show the effect of the disease, the cause, and method of treatment.
4. If it is possible, make a collection of diseased plants.
5. Look up the experiment on "Plant Nutrition" in an earlier book of this series. Set up the experiment again to show the effect of mineral deficiency in plants.

Collect all your material for 1 to 5 together and arrange it as a display on "Animal and Plant Diseases".

CHAPTER TEN

BIOLOGY AND INDUSTRY

CHOOSING A JOB. Very soon many of you will be leaving school to start working in a factory, mine, farm, office, or shop. Perhaps some of you have decided what you would like to do, while others cannot make up their minds. Certainly, you will have wondered how you were going to start.

In the past, a boy or girl learnt from some friend or from an advertisement that there was a vacancy in some office or factory, and applied for it. Even now this happens in many cases. He may not be suited for it physically or mentally, or he may be able to do the work but not like it very much or not be very happy in it. However, he takes the job because it is a job, or because circumstances at home compel him to. This is very unsatisfactory, and very often the boy or girl soon tires of the work and looks for another job.

In many cases now, children about to leave school have the chance of meeting the local Juvenile Employment Officer who advises them on what jobs will most likely suit them, and makes suggestions as to where to apply for a job in the district. Some schools have a careers master who gives this advice to leavers.

Recent discoveries by biologists and psychologists about the working of the body and the mind have shown us how important it is to place a person in the job that will suit him mentally, physically, and temperamentally; that is, a job in which he will find most satisfaction and happiness. Therefore, throughout a child's school career records will be kept of his health, physical ability, examination results,

and character. In addition, tests will be given which will help to show what occupation is most likely to suit him.

Besides the testing and advice given at school, many industrial firms also set applicants for jobs a selection test to see what work they are best suited for. This selection test may consist of an interview, intelligence tests, and tests to find how good the person is at doing certain practical jobs. As a further precaution, all young persons under sixteen years of age entering industry must be medically examined to see what jobs they are not suited for physically.

By means of this guidance and testing it is hoped that a young person will be fitted to a job which he will enjoy doing and that he will thus produce good work. This is

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Applying for a job. What does the future hold for him? Will he be happy at his work? Will he be a good worker?

very important, for if a young person is unhappy at his first job and leaves it, he may become discouraged, and he runs the risk of never settling down at any one job.

In the rest of this chapter we shall deal with workers in factories, i.e. industry.

TRAINING FOR THE JOB. Nowadays many firms take steps to see that a newcomer is made to feel he is one of the firm. He may be given information on what the firm produces and the rules of the factory. He will be told what health and social services are provided, where the first-aid and rest-rooms are, and what the safety and fire regulations are. This attempt to make the new worker feel at home will make him feel more at ease and happier; a happy worker is a good worker. The new worker will then be trained for the job he is going to do. In some progressive firms young employees are first trained on simple machines working at a slower rate than the real machines. At the end of this training period he is given a test to see if he has learned the job successfully. This not only reduces the number of accidents, but it also reduces damage to machines, and helps to increase production.

CONDITIONS IN THE FACTORY

Conditions of work vary enormously from factory to factory, and even in one factory from workshop to workshop. At one time little attention was paid to these conditions; all that mattered was production and profits. Now, we have learned from the research work of doctors and biologists interested in industrial health that the environment in which a person is working influences both himself and his rate of working, and must therefore be studied seriously. Let us do this now.

(*By courtesy of J. S. Fry & Sons Ltd.*)

Packing chocolates in a modern factory in Bristol

FATIGUE. After anyone has been working hard, or for a long time, he needs a rest period before he can do any more useful work. If he does not take a long enough rest, and regularly goes on working when his body is still tired, his health and his capacity for doing useful work will be seriously imperilled. Tiredness or fatigue not only affects a person physically, but also mentally, so that he cannot think clearly, and often becomes irritable and bad-tempered.

This question of fatigue is a very important one in industry, for a tired person works at a slower rate and often produces poorer work. Because his muscles are tired and he cannot think clearly, he is more liable to have

an accident. His powers of resistance to disease may be weakened, so that he becomes ill and a possible source of infection to others.

Scientists in recent years have studied the conditions in factories, shops, and offices that lead to fatigue, and have suggested steps for dealing with them. Amongst the conditions leading to fatigue are the following:

1. Long hours of work with inadequate rest periods.
2. Strenuous muscular work.
3. Excessive repetition of some process leading to monotony.
4. Lack of seats or, in some jobs, prolonged periods of sitting.
5. In some jobs the continual performance of some awkward movements such as stretching, twisting, and bending.
6. Mental strain.
7. Bad temperature, ventilation, and lighting.
8. Noisy conditions.

We shall discover these as we consider what is being done to reduce fatigue amongst workers.

HOURS OF WORK. Last century the working day was usually one of ten to twelve hours with a working week of fifty-five to sixty hours. These long hours resulted in much fatigue amongst workers, and the trades unions began to appeal for a reduction in the working week. Many enlightened employers had already done this.

After the First World War the working week in many factories was reduced to forty-eight hours. In spite of what some employers believed, the amount of work done per hour in the shorter week was greater than that done per hour in the longer week. This was due to the fact that

the longer hours available for relaxation led to quicker recovery from fatigue, and also reduced the amount of fatigue occurring.

Since the Second World War there has been a demand for a forty-hour week or a five-day week. This raises problems which you will be able to discuss in your English lessons, such as, "How are these shorter working weeks affecting production?" and "What provision is made so that workers make good use of the extra time for leisure they are getting?"

MAKING WORK EASIER. In many instances fatigue is due to awkward postures, to the speed at which some work has to be done, and to the constant repetition of unnecessary movements. Until recently little thought was given to the person who would operate machines. This often meant that the person had to work in a cramped space, or had to stretch and bend first to one side and then to the other. In addition, working benches were often made too high or too low or too wide, and this often meant the operator had to work in some awkward posture. Very often machines were made to work at fixed rates which were frequently too fast for the pace at which many workers normally worked.

Within recent years, psychologists and biologists studying these problems have been responsible for many improvements. In the construction of machines and factory and office fittings more attention is now paid to the people who will operate or use them. The tools and materials a worker has to use are placed in convenient positions, seats are often adjustable, anyone who uses them sits comfortably, while the speed of a machine may be adapted to the normal pace of the operator. Even the design of tools is an important matter and is being studied

extensively. Here is an example from a factory assembling electrical fittings. During this assembly screw-drivers were used extensively. When small screw-drivers were used instead of large ones, there was less fatigue amongst the workers and the output increased by over 15 per cent.

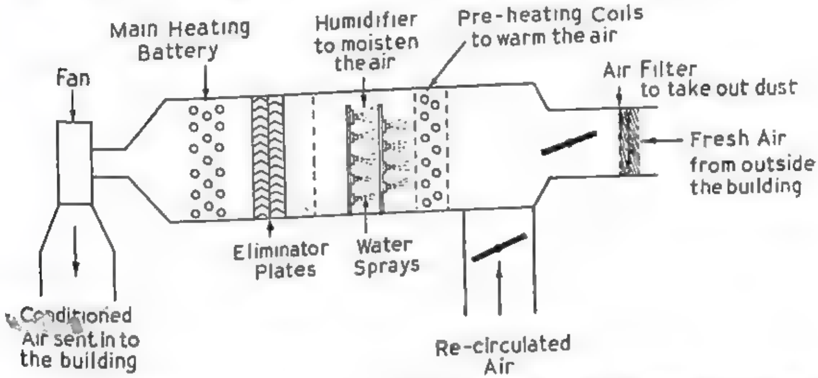
In many factories and offices where the repeated performance of some operation may lead to monotony or boredom, or where the workers sit or stand for long intervals, rest pauses are introduced during which the worker may relax, have a cup of tea, or smoke a cigarette. These provide a useful break and give some chance to reduce fatigue. Music is frequently relayed, and for this purpose the B.B.C. provide "music while you work" programmes.

TEMPERATURE AND VENTILATION. Temperature in a factory has an important influence on the employees' health and work. Man is found to work best at temperatures between 60° and 65° F. Temperatures below this are uncomfortable; and if they are above 65° F. work slows down and fatigue is more evident. But if strenuous muscular work is being performed a temperature range of 55° to 60° F. is often more comfortable.

Closely linked with the question of temperature is that of ventilation. By means of a good ventilation system the air is kept moving and fresh, concentrations of bacteria are removed, and, in factories where large quantities of dust and fumes arise, these are carried away. In workshop and offices where ventilation is bad the employees frequently suffer from headaches, easily become fatigued, and are more subject to infection.

Usually, the ventilation is carried out by allowing air to enter through open windows and go out by the chimney, skylight, or door. As warm air rises, it is often arranged

that the inlet should be low down and the outlet at a higher level. By this means a stream of air will be kept flowing through the workshop or office. Frequently fans are used to set up better air currents. In some modern offices and factories an air-conditioning plant is used. Before entering the building, cold air passes through the air-conditioning plant which filters dust and bacteria out, and moistens and warms it to a suitable temperature.



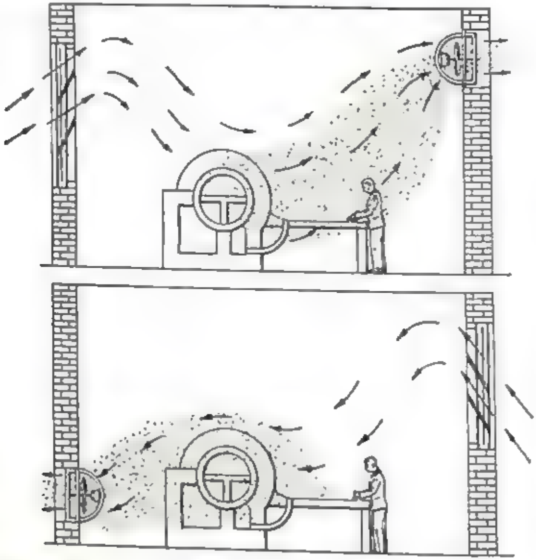
(Redrawn from Bedford: Modern Principles of Ventilation and Heating—H. K. Lewis)

A diagram of an air-conditioning plant

In any system of ventilation two points have to be considered from the point of view of health. Draughts which might cause colds or discomfort must be avoided, and any harmful fumes, dust, and particles which might be produced in some process must be removed from this air of the room or workshop. Some of these dusts not only cause lung trouble, but often may injure the eyes and lead to skin irritations.

The removal of these injurious dusts and fumes is thus very important, and in general three methods of doing it are employed. A careful system of ventilation can be used

which carries the dusty and fume-laden air away from the machine and *not* to the workers. As you can see from this diagram, this may mean that the outlet is put at a lower level than the inlet:



Incorrect and correct methods of ventilation in a dusty process

Some factories supply masks and respirators to workers engaged in occupations where they are liable to breathe dangerous dusts and fumes. This, however, is often not satisfactory, as a mask handicaps the worker slightly, and he frequently discards it. This silly behaviour may easily lead to trouble. A better method that most factories have adopted is to fit hoods round the machine parts where the dust or fumes are formed. These hoods are attached to tubes or ducts connected to suction pumps, which draw the dust and fumes into the ducts so that they do not reach the workers.

LIGHTING. Since man makes more use of his sense of sight than of any other sense, it is vital that the lighting in a workshop or office should be adequate and suitable. Bad lighting causes eye-strain, and this in turn leads to headaches, nerve-strain, and causes irritation; accidents and fatigue increase. The main faults may be insufficient lighting, so that the worker has to strain to see what he is doing, a flickering light which is very irritating, glaring or dazzling lights, and badly placed lights which cast a shadow on the work being done. The intense heat experienced in some jobs also tends to cause eye-strain. Bad lighting not only results in eye-strain; it may mean that a worker has to bend closer to the machine, so that he or she runs more risk of breathing dust from the machine and also of being caught in it. Unfortunately, many factories are badly lighted.

(By courtesy of the Lighting Service Bureau (E.L.M.A.))

Modern lighting in an old factory

Architects and scientists have given much thought to the problem of lighting, and in recent years a number of factories have introduced lighting systems using ceiling lights and bench lights where necessary. Particularly is good light required where fine work is being done, as in needlework and type-setting. Most of the light falling on a bench or machine is not direct daylight or lamplight, but is light reflected from the walls and ceiling. Because of this, walls and ceiling are painted some pale colour to increase the light reflection. Such pale colours often make the room or workshop more cheerful. Where they are used the walls and ceiling have to be cleaned more frequently, and this makes, too, for a healthier atmosphere, since bacteria settle on the dust on walls and ceiling.

If use is being made of daylight entering through the wall windows, the lighting in the central parts of the building away from the walls may not be sufficient. To overcome this in one-storey buildings and in the top storey of other buildings, a "saw-tooth" roof is frequently used, with the windows facing north, if possible, and forming the short edge of the "tooth".

(*Aerofilms, Ltd.*)

A modern factory with a roof designed to give the best natural lighting

A good lighting system benefits both the employee and the employer. The absence of eye-strain means an improvement in health and enables the workers to produce more and better work. It also does much to reduce the rate of accidents.

NOISE. One of the evils of our modern age is noise; the noise of traffic, the din of machinery, and the roar of aeroplanes. Even in the home people have their wireless sets on all day, often at full blast, and give little rest to their ears. This is very wearing to the nerves, although we may at the time not be aware of it. In some industrial processes the intensity of noise not only effects the nerves but can cause deafness. This is especially the case amongst boiler-makers, who have to stand the incredible din made by compressed-air riveting machines inside the boilers.

Something is being done now to reduce noise by improvement in machinery and by the introduction of new materials in the construction of machines and workshops.

PREVENTION OF ACCIDENTS. Amongst the most serious sources of trouble in industry, both to employee and employer, are accidents. They cause loss of valuable lives and limbs, enforced stay in hospital, reduce production, often lead to damaged machinery, and the spending of vast sums of money on medical and surgical treatment.

In some cases the accidents are due to the use of power-driven machinery and the necessity for handling heavy and dangerous materials. A tired worker or one working under some strain is not able to think as clearly as he should, and this leads to accidents. But the greatest cause of accidents is human carelessness and failure to use safety devices which have been fitted on machines to prevent accidents. Another serious cause is the use of dangerous practices to

"save time or labour". Thus a workman, instead of stopping a machine to clean it, cleans it while it is still running. He has probably done this several times, although it is against the factory rules, and he gets into the habit of doing it. Nevertheless, he is running a great risk, for it is easy for his oily rag or his clothing to be caught in the moving machinery and thus for an accident to occur.

It is interesting to note that there are some people who appear to be accident-prone. Under any given conditions these people seem to run the risk of accidents to a far greater extent than other people.

What is to be done about it? Since the main cause of accidents is man's carelessness and not machinery, the most important step is the training of workpeople in safe ways of handling machines and tools, and in safety habits. This training in some factories is done by safety officers, who instruct and train new workers, arrange accident prevention campaigns in the factory, and go round the factory to see everything is being done correctly, that passages are free from obstruction, that machines are in good working condition from the point of view of accident prevention, and that lighting and ventilation are good.

Where machines are a source of danger, safety devices are often installed, especially round moving parts. Special clothing and masks are provided in some dangerous processes. To ensure that safety devices are used and that conditions of working are good, Parliament has passed several Factory Acts which say what must be done, and factory inspectors frequently visit factories to see that the conditions of the Factory Acts are in force.

Psychologists have devised tests to tell if a person is prone to accidents and, by using these, factory managers can place accident-prone employees in jobs which entail the least risk of accident.

(Crown Copyright Reserved)

Guards prevent shocks and accidents from moving machinery

When you leave school and start work in an office or factory, you should carry out all the safety instructions which may be given you, and make sure you do not fall into the habit of using "little dodges" to save a little time, a little back-bending or other effort. No matter how small, if any accident does occur to you, you should report it. It may be the fault of the machine, and your reporting it may lead to some alteration in the machine to prevent the accident occurring again. Even a small cut, when neglected, can become septic and lead to absence from work. Every year 30,000 workpeople in Britain are absent for three days or more because of factory accidents which have become septic, often through neglect. Furthermore, as the person with the septic wound uses tools, towels, and utensils, the infection may spread to other employees.

FACTORY SERVICES

Before the First World War, it was often not sufficiently realised that healthy, contented workers were the best workers. Now we pay the utmost attention to the conditions in which the employee is working, and particularly to factory hygiene. For this purpose various services are provided, and these we will consider briefly.

CLOAKROOMS. The Factory Act, 1937, states that cloakrooms must be provided, sufficient for the use of all employees, and that arrangements should be included for drying wet clothes. This is important, since a tired worker putting on damp clothing at the end of the day's work becomes chilled and more liable to be infected by bacteria.

SANITARY CONVENIENCES. By law, sufficient and suitable sanitary conveniences must be provided. In many factories, shops, and offices old types are still in use. But even where modern ones are installed these are often left in a filthy condition. This is a serious threat to health, and is largely due to thoughtless and ignorant employees who have not learned the good social habit of using WCs properly. A dirty convenience is a dangerous source of bacterial infection. So when you begin work in an office or factory, use the conveniences in a proper manner, and leave them as you hope to find them—clean and tidy. You should at once report any complaints about insanitary conveniences to the factory medical officer, nurses, or welfare officer.

WASHROOMS. A good factory provides sufficient wash basins, soap, and towels for its employees. But there are

still factories with none at all, and some which provide a dirty sink in some dark, cold passage. Good washing facilities are necessary, not only to enable the workers to clean themselves, but to reduce the danger from infection, and also to wash off the hands and face any injurious substances picked up in the course of work. The towels, of course, should be changed frequently. Unfortunately, some workers cannot refrain from stealing the soap and towels provided, which is unfair to their fellow-workers and makes it difficult for the employer to maintain a good clean supply of towels.

DRINKING WATER. A good factory provides supplies of drinking water for its workers. If it is supplied from a tap, you should try to use your own cup, but if a cup is provided, see that it is clean and rinse it out well before using it. The best method of supply is through a fountain jet so arranged that it is impossible for the drinker to place his lips to the nozzle. In this way the risk from infection is reduced.

Everything possible should be done by employers and employed to see that all these services are kept in good condition and used properly. Sanitary conveniences, cloakrooms, and washrooms should be kept clean and regularly washed or sprayed with disinfectants. This, combined with cleanliness in the office and factory, would lead to better health amongst the workers.

HEALTH SERVICES IN INDUSTRY. In a report of the British Medical Association the following statement is made:

> "When a worker takes up employment in a factory he has a right to expect that adequate precautions will be taken to safeguard his health, his safety, and his welfare."

We can readily understand how important the matter of industrial health is when we realise that in Britain every year over 30 million weeks' work is lost through ill health. Imagine what this means in loss of production and in financial loss to the country. What is worse, it means expense, pain, anxiety and worry, and inconvenience to the sick persons and their families. Much of this sickness is contracted at work through infection or accident, or may be the result of working conditions. Not all this sickness is physical sickness, for within recent years there has been a growing number of cases of mental and nervous sickness due to the increasing speed and strain set up by the use of modern machinery. This strain may not show itself until it results in some physical illness. For example, worry about work may finally result in dermatitis, duodenal ulcers, and digestive troubles.

From this it is clear that health services must be provided in industries. We take care to provide "machine-doctors" or engineers to look after the machines and keep them in good running order. It is just as important, and indeed more important, to provide health services to look after the health and welfare of the men and women who build and operate the machines.

Towards the end of the nineteenth century a small number of firms realised this, and appointed their own works medical officers. In 1898, the Home Office appointed its first Factory Medical Officer. Gradually the idea grew until by 1944 there were about 175 whole-time and 700 part-time works doctors.

Perhaps you may be wondering why it is necessary to appoint a works doctor when each worker will have his own private doctor whom he can consult when ill. There are some very important reasons. In the first place, the works doctor's object is to try to *prevent* sickness, while

the ordinary or private doctor's main job is to *cure* sickness once a person is ill. The works doctor knows the conditions in the factory and is aware of the likely effects on the health of the employees. He sees the worker in the conditions which may be the cause of his sickness and can take steps to remove the cause. The private doctor sees the patient only in his surgery or at the patient's home and generally has little knowledge of factory conditions. Again, many workers do not like taking time off to see a doctor, but are quite willing to see the works doctor, who is on the spot and can be consulted without any loss of time.

Let us see now what factory health services there are and what such services do.

First, there are the official steps taken by the Government to ensure better conditions in factories. The first Factory Act was passed in 1833, and this was followed by many others until all the provisions made in these Acts were brought together in one Act, the Factories Act of 1937. Factory inspectors appointed by the Home Office visit factories to see that the Factories Act is being observed. The public health inspectors of the district in which a factory is situated can visit it to see if anything is wrong with the sanitary arrangements, ventilation, cleanliness, and drainage. There are also medical inspectors appointed by the Government to examine the health services of factories and to investigate any matters concerning industrial diseases.

Many factories have their own health services. If the firm is a large one employing, say, over 500 persons, it may have a full-time medical officer. Smaller firms generally appoint a part-time medical officer, or two near-by small firms may appoint one between them. Such a works medical officer must not only possess the usual medical experience, but he must also have some knowledge of

industrial conditions and their possible effects on the mental and physical health of the employees. Amongst his responsibilities will be the following:

1. To keep careful watch on the general health of the employees.
2. To see that sanitary arrangements, lighting, heating, and ventilation are good, and to advise the employer on hygienic conditions in the factory.
3. To take all measures to prevent disease breaking out in the factory. If it does, to do all he can to prevent it spreading.
4. He will be responsible for the organization and running of first-aid services and rest-rooms.
5. He will medically examine any person who is about to be engaged on some specially hard or dangerous process, to see if that person is fit for the job.
6. He will medically examine any employee returning to work after a period of illness, to make sure he is fit to return.
7. He will medically examine any new entrants into the factory.
8. By means of lectures, talks, films, posters, and booklets, he will advise workers on matters of personal and general hygiene.
9. He will keep a confidential record of all the work he does.

A good works medical officer will keep in close touch with the local public health authorities, local doctors, local hospitals, and the welfare services of the district. For example, a worker may have been seriously ill for some time and has been attended by his own doctor. When he recovers and returns to work, a good works medical officer would communicate with the man's private doctor to see whether the man should go back to his old job or be given a lighter one. It is this close co-operation between all the health services which will provide the best means of maintaining sound health amongst employees.

A wise factory medical officer will not only pay attention to physical complaints, but will also be on the look-out for any mental or emotional strains and upsets, for these can easily lead to physical disease and fatigue. He will look

to see if the length of time a man is working, or the type of work he is doing, or the method of supervision of him, is resulting in nervous strain. An interesting case of this was reported recently. A girl who had worked happily for five years in a factory suddenly developed a nasty skin disease, dermatitis, which refused to yield to any treatment. There seemed to be no physical reason for this. It was eventually discovered that the disease started shortly after the appointment of a new overseer who was always nagging at the girl. The girl became miserable and worried, and this resulted in the physical disease dermatitis breaking out. Immediately this was discovered the girl was moved to another department, doing the same job under happier circumstances, and she recovered. This is the kind of thing that the factory medical officer must spot.

(*By courtesy of the Gloster Aircraft Co., Ltd.*)

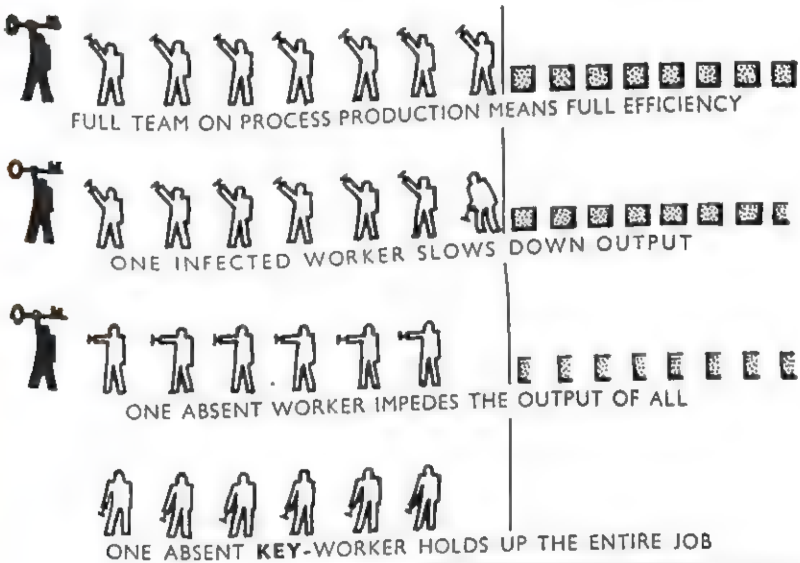
The Sick Bay in an aircraft factory

To assist the works medical officer, a nurse and assistant nurses are appointed, whose job it is to deal with all minor cases of injury and sickness in the works. The nurses will also assist in medical examinations and in giving advice on matters of personal and general hygiene.

To carry out these health services many factories provide a surgery, doctor's consulting-room, waiting- and dressing-rooms, and rest-rooms. Some "go-ahead" factories provide special additional health services by the use of which their employees benefit greatly in better health. Bad teeth are the cause of much ill health—indigestion, gastric troubles, tonsilitis, and even influenza. Some firms, aware of this, have their own dental services, and they say that because of the attention paid to their employees' teeth there is less absenteeism through sickness and a consequent increase in production. Similarly, a number of factories have eye services and foot treatment. Some works arrange for their employees to have sunray treatment during work hours. This is especially beneficial to miners and others who work in dark conditions, for it seems to increase their resistance to disease and helps to keep them fit.

Quite recently a number of factories have had their employees radiographed in order to find if tuberculosis is present. If tuberculosis can be detected in its early stages, perhaps only a short course of treatment will be necessary. If it is not detected until the symptoms become obvious, then it may mean prolonged treatment and years of illness with consequent uselessness as a productive worker. Mass radiography makes early detection possible, and a large number of workers can be dealt with in a morning or afternoon session. In some cases the employees go to the radiography unit which may be in the town's Public Health Department, or a mobile unit may visit the works.

Epidemics, whether they start in the factory or outside, cause much absenteeism through sickness. The worst offender is the common cold which is spread by tiny droplets of moisture infected with bacteria being sneezed, spat, or coughed out. One employee suffering from a common cold can soon spread the infection to other employees, and thus the whole production of that particular factory is slowed down.



(By courtesy of Newton, Chambers & Co., Ltd.)

What lesson does this diagram teach?

In an attempt to combat this danger some firms have their offices and workshops sprayed once or twice daily with a spray which they hope will kill the bacteria. It is, however, difficult to produce a really satisfactory bacteria-killing spray. In some cases, during a common cold or influenza epidemic, employees have been supplied with

masks covering the nose and mouth. As the wearer breathes, the mask prevents bacteria entering his nose and mouth. This should be quite effective, though few workers will keep the mask on for any length of time.

REHABILITATION. Rehabilitation means restoring a person to complete fitness for life after an accident or serious illness, whether it is physical illness or mental illness. Up to the Second World War it was thought that if a person had an accident, the job of healing was complete if he were sent to hospital and had the fractured limb healed. We now realise that this is not enough, for although the limb may heal well, the person disabled in some way may be generally unable to follow his employment. In England and Wales alone in 1939 there were over 200,000 people unemployed because of disability due to accidents, and the number was growing. Such disability meant more than unemployment. It meant worry, depression and despondency, idleness, poverty, and misery for the person and for his family, and a lowering of the standard of life. This was indeed a serious matter, and it was realised that healing treatment was not enough, that rehabilitation treatment was necessary as well. That is, everything must be done to enable the disabled person to return to his former job or at least to some form of occupation as soon as possible.

We now further realise that disablement may not be the result of a physical injury or accident only, but that disablement may also be due to mental and nervous sickness. Until quite recently very little was done for disablement cases, except to send them home, where they spent their time just resting, and generally making little effort themselves towards complete recovery.

Now, when a person is injured or suffers from some

serious mental or physical illness, he is not only treated for the injury or sickness, but at once steps are taken to prepare him for return to full life. This may be done in occupational therapy (healing by occupation) or rehabilitation centres attached to hospitals. The patient is given some simple tasks to do, such as needlework, basket-work, woodwork, and gardening, which will occupy his mind and give him some muscular exercise. Simple exercises for an injured limb will be given; these gradually becoming more difficult until the limb regains its former power and the person returns to his old job. If full power in the limb cannot be regained he will be trained for some other job.

In some cases, especially those suffering from some disablement due to nervous sickness, the rehabilitation centre may be in the country, where the patient stays until he has made complete recovery. When he arrives, doctors will make physical and psychological examinations and will discuss any difficulties and problems which may be facing the worker. In this way they often discover what is preventing him from making a full recovery. While at the centre he will be given daily a graded course of gymnastics, designed especially for his case, to help him in physical recovery. In addition, he will be encouraged to do some physical task like gardening, woodwork, or painting, swimming, and walking, or a woman may be encouraged to do laundry-work, handwork, or needlework. To stimulate mental activity, discussion groups, film shows, music classes, and lectures are arranged. Frequently, the patients are allowed home at week-ends, and visits are arranged for their relatives. Particular attention is paid to the food, and to see that the patient gets sufficient rest. In all this treatment you will notice that the patient himself is taking an active part in his own recovery; it is not left to the doctors only.

Before the Second World War, unemployment with all its attendant miseries was one of the worst features of our national life. It is now realised that unemployment is a drain on the nation's industry and resources, and that it is urgently necessary, both for the individuals concerned and for the nation, to see that everyone capable of working is in full employment. This can only be done if by rehabilitation we can return those disabled from accident or sickness into some employment that they can follow. Indeed, it is our duty to see that they are helped in their return to a life useful to themselves and to the community.

RESEARCH IN INDUSTRIAL HEALTH. You will probably realise by now how important is the question of health in industry, both to the employee and to the employer. To the employee, good health means regular employment and a full life; to the employer, it means regular and increasing production. It is strange, then, that we have not in the past paid all the attention it deserves to research in industrial health, and to the training of doctors in industrial health. This is the concern of everybody engaged in factories, shops, and offices. Any industrial health problems that arise should be reported, so that research workers can find the answer, and their findings be put into practice.

Amongst organizations carrying out research in industrial health is the Industrial Health Research Board set up by the Medical Research Council in 1942. This council is also responsible for the Department for Research in Industrial Medicine in the London Hospital.

There are many industrial health problems which still need much studying. For example, we know little of the effects of night work on workers. Our knowledge of physical diseases caused by some emotional upset is still

in an elementary stage. Many new materials are being used in modern industry, some of which have a poisonous effect on those handling them. Often these are introduced into industry without being first tested to see what effect they may have on the workers. Industrialists in the past were mainly interested in the use of the new substances and were little concerned about their effects on the workers. This is wrong. Any new material about to be used in some industrial process should be first submitted to tests to find what effect it may have on people engaged in working the process.

WELFARE SERVICES IN INDUSTRY. When do you work best in school—when you are feeling happy, or when something has upset you? Of course, you work best when you are happy. This is true also in the factory where the best worker is the happy worker. If a worker is discontented, perhaps because he does not like his job, perhaps because of some little grievance, or perhaps because the relations between the manager, foreman, and worker are not happy, then his value as an efficient worker decreases. The discontent may not only affect his work, but his health also.

Many firms know this and have devised various means of seeing that their employees are happy. They have also provided the means whereby a worker with a grievance can state his complaint. The chief methods adopted have been through the appointment of *welfare officers*, and the setting up of *works councils* and *joint production committees*. These councils and committees consist of representatives of employees and employers and managers. They meet in joint consultations to discuss matters of production and also matters concerning the welfare and health of the workers and staff. Complaints can be put forward and discussed sympathetically.

Quite a number of firms try to interest their employees in the whole work of the firm, and get them to feel they are an important part of the whole concern. By means of the works councils, bulletin boards, and works magazines the employees are kept informed of what the firm is doing and hopes to do.

Through the appointment of welfare officers the management can keep in close touch with its employees. Then the workers can turn to a sympathetic welfare officer when they want advice on some personal problems and difficulties. He works closely with the Health Services, organising accident-prevention and better health campaigns, and keeping in touch with employees who are or have been recently ill.

An increasing number of factories and offices are providing excellent social and recreational facilities for their employees. These are organised and run by committees of the employees and welfare officers. In addition to football, cricket, tennis, bowls, and other games, dances, discussion groups, and visits to concerts are often arranged, and allotments provided for those interested in gardening. This not only provides recreation for the employees, but binds them together into a social group and develops a good community spirit. It is not compulsory to take part in these social activities, nor in any other of the outside welfare services which some firms provide, such as facilities for attending classes at day or evening schools, and the provision for convalescent treatment. Some firms through their welfare officers also make arrangements to provide special bus facilities to and from work.

Since a contented worker, free from any worries, is usually also an efficient worker, many firms through their welfare officers often help their employees by giving them assistance in housing problems, by providing legal

advice when needed, and financial assistance in times of hardship.

Soon you will be one of the great army of workers in shops, offices, factories, farms, or in mines. Take an interest in your work and learn all you can about it. Make full use of all the health facilities provided, obey the safety rules made for your benefit, and take part in the educational, social, and recreational activities.

(*By courtesy of J. S. Fry & Sons Ltd.*)

Many factories have their own sports fields

A LITTLE INDUSTRY WILL HELP YOU TO DO THESE:

1. What job do you hope to take up, and why?
2. What is done in your district to help school-leavers in choosing the most suitable jobs?
3. Some school-leavers never settle down at a job. What may be the cause and why is this bad?
4. What is done by firms in your district to select and train young workers for a job?
5. What is meant by fatigue and what are its effects on a worker?
6. For the working members of your family—find how many hours a day they work and how many per week. Make a record of this.
7. Can we go on shortening the working week without reducing output?
8. Write an essay on "Reduction of fatigue in industry".
9. Look round your kitchen at home. What labour-saving devices do you use to cut out unnecessary movement and labour? Can you suggest further improvements?
10. How is your school ventilated and heated? Are the methods satisfactory? If not, how would you improve them?
11. What harm is caused by industrial dusts and what steps are taken to reduce this danger?
12. What is the effect of bad lighting in an office or factory?
13. What can be done to improve lighting?
14. What noises assail your ears during the daytime, and is there any period during the day when you are free from noise?
15. What is the main cause of accidents in a factory?
16. What is done to prevent factory accidents?
17. Why is it necessary to have factory medical officers?
18. What can a factory health service provide for its employees?
19. What steps are taken by the Government and local health authorities to maintain good conditions in factories?
20. What is meant by rehabilitation and how is it carried out?
21. What is the job of a welfare officer in a works?

PROJECT WORK

1. Visit a factory or office in your neighbourhood and find out all you can about conditions of working, and the health and welfare services available. Write an illustrated report on your visit and, if possible, arrange an exhibition of photographs, charts, and other material to illustrate what you observe.
2. Such a visit may form part of a larger study of "INDUSTRIES OF THE NEIGHBOURHOOD" carried out by several classes in the school—covering geography, history, etc.
3. Visit the local Sanitary Office or Public Health Department, and find what work is done in connection with factories of the neighbourhood. Write a report on this.
4. Imagine you are the safety officer in a factory. Arrange a "Safety in our Factory" exhibition. You can get material for this from your local factories, and from the Royal Society for the Prevention of Accidents, Terminal House, 17 Knightsbridge, London, S.W.1.
5. Visit a local factory and find all the steps taken to prevent accidents.
6. Visit a local factory and find all that has been done to reduce fatigue in the factory.

CHAPTER ELEVEN

MORE ABOUT FOOD

HOW MUCH FOOD DO WE REQUIRE? In Book Two we discussed at some length the reasons why we required food and what kinds of food. We discovered that we must have the following:

1. *Carbo-hydrates* (sugars and starch) and *fats* to give us energy and to keep us warm.
2. *Proteins* also to give us energy, but mainly for growth and repairing the body.
3. *Minerals* also for growth and repair. They are necessary, too, for the correct working of certain processes in the body.
4. *Vitamins* to keep the body healthy, and for the carrying out of certain processes in the body.

We did not mention at all, however, *how much food we require*. Yet this is very important.

A survey carried out in Britain before the Second World War revealed that over 40 per cent of the people were regularly having meals deficient in all the food groups—energy-givers, body-builders, and body-protectors; 30 per cent, though getting sufficient energy-giving foods, were lacking in body-building and body-protecting foods; 20 per cent were having meals seriously lacking in vitamins and minerals. Thus only about ten out of every hundred people of this country were getting meals providing all the necessary foods in correct quantities. It was found that too much starchy food and sugar were being consumed and not enough fish, meat, eggs, milk, fruit, and vegetables.

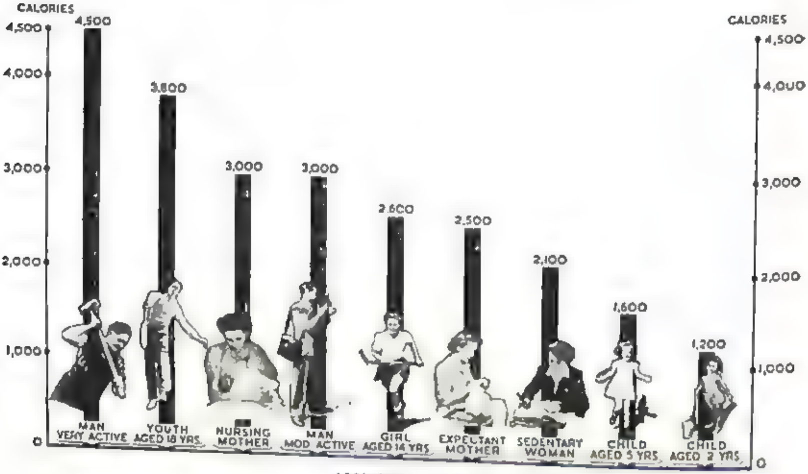
For example, too many children were getting meals consisting of carbo-hydrates mainly—bread and butter with jam or syrup. The food eaten varied largely with the income of the people. Sir John Boyd Orr, the great expert on nutrition, from an inquiry carried out in 1935, showed that the poorest people spent less than half the average expenditure on food and spent this small amount on those foods which seemed to be most filling—starch and sugar foods. They could not, or would not, buy fish, fruit, vegetables, and meat which, though more expensive, provided the proteins, vitamins, and minerals so urgently needed. But even where the income was sufficient, fault was to be found with the diets.

"How much food is required?" is a problem which clearly must be answered, and this we shall now try to do.

FOOD FOR ENERGY. By far the larger part of the food we eat is used to provide us with energy, that is, the power or the ability to do things. But how much energy do we require? How do we measure it?

Just as we measure the weight of a substance in units called ounces or grams, and time in units called minutes and seconds, so scientists use a unit for measuring energy. This unit is the *Calorie* or large calorie. It is the same unit as we use in science to measure heat, for heat is really another form of energy. The Calorie is the amount of heat energy required to raise the temperature of 1,000 grams of water 1° C. The amount of heat required to raise 1 gram of water 1° C. is called a calorie or small calorie. You will see that 1 Calorie (large calorie) is equal to 1,000 calories (small calories). In physics and chemistry the small calorie is usually used, but in biology, in measuring energy, the large calorie or Calorie is used. Thus, if you take a beaker containing 1,000 grams of water at 20° C.,

and you heat it over a Bunsen burner so that its temperature goes up from 20° C. to 60° C. i.e. a rise of 40° C.. from the gas burnt you obtained 40 × 1,000 calories of heat energy or 40,000 calories = 40 Calories (large calories).



(Ministry of Agriculture, Fisheries and Food copyright)

Calorie requirements per day

By burning coal or oil or gas or any fuel in an apparatus known as a calorimeter we can measure in Calories how much energy is given out. If instead of using coal in the calorimeter, we use carbo-hydrates (sugar or starch), fats or proteins, we can measure how much energy they give out. By such experiments it has been found that when proteins, carbo-hydrates, and fats are burnt or oxidised in a calorimeter they produce the following amounts of energy:

1 gram of *proteins*	produces 4·1 Calories of Energy
1 gram of *carbo-hydrates*	produces 4·1 Calories of Energy
1 gram of *fats*	produces 9·3 Calories of Energy

or in English units of weight:

1 oz. of *proteins*	produces 115 Calories
1 oz. of *carbo-hydrates*	produces 115 Calories
1 oz. of *fats*	produces 260 Calories

Exactly these amounts of energy are produced in the body when 1 gram or 1 oz. of protein, carbo-hydrates, or fat is "burnt" or oxidised in the body. Thus if we eat 2 oz. of sugar this will be oxidised or "burnt" in our body and will produce 2×115 Calories of energy, i.e. 230 Calories.

Here are the energy values of some foods:

AVERAGE AMOUNTS OF ENERGY FROM ONE OUNCE OF FOOD

Food	*Calories per ounce*	*Food*	*Calories per ounce*
Cooking Fat	253	Potato	21
Butter	211	Banana	21
Bacon	128	Milk	17
Cheese	117	Apples	12
Sugar	108	Orange	10
Beef	89	Cabbage	7
White Bread	73	Turnip	5
Dates	68		

From the *Manual of Nutrition, 1947*, published by the Ministry of Food. (H.M.S.O.)

You will see at once that the foods giving the biggest quantities of energy are the fats. Perhaps from this you will be saying, "If we are to get energy from our meals, they should include a good deal of fats". This, however, is not the case, for there are other things which must also be considered. The body cannot deal with too much fat without signs of distress like headaches and biliousness. Again, fats are much dearer than carbo-hydrate foods, so that 100 Calories of energy obtained from fat is dearer

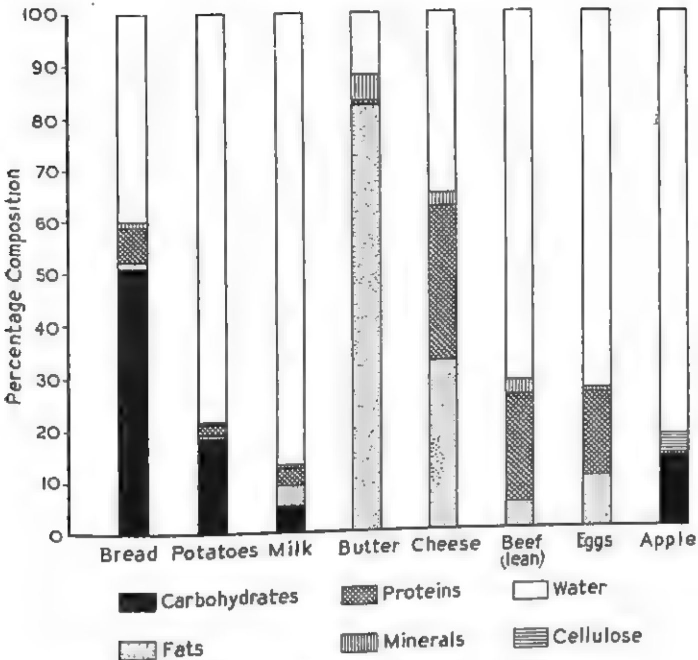
relatively than 100 Calories of energy from carbo-hydrates. So if we are wise we get our energy, not mainly from fats but from carbo-hydrates, fats, and proteins.

We have discovered how much energy is provided by some of the commoner foods we eat. We have now to learn how much energy a person requires from the food he eats. But first we must learn what he requires the energy for. The body uses energy for the following purposes:

1. To keep all the vital activities of the body going —beating of the heart, circulation of the blood, respiration, digestion.
2. To keep the body temperature up to 98·4° F.
3. For all the daily activities—moving, dressing, standing, having a meal, bathing.
4. For muscular activity connected with our work and games—writing, washing and ironing, lifting heavy weights, working machinery, etc.

PERCENTAGE COMPOSITION OF SOME FOODS

	Carbo-hydrate		*Fat*	*Protein*	*Minerals*	*Water*	*Cellulose*
	Starch	*Sugar*					
Bread	49	2	1	7	1	40	—
Potatoes	17	1·5	0·5	2	0·5	78·5	—
Rice	77	—	0·5	6	0·5	16	—
Syrup	—	83	—	—	0·5	16·5	—
Milk	—	5	4	3	0·7	87	—
Butter	—	—	82	1	5·0	12	—
Cheese	—	—	32	30	3·0	35	—
Beef (lean)	—	—	5	20	3·0	72	—
Eggs	—	—	10	15	1·0	74	—
Apple	13·0		—	—	0·5	82·5	3·0
Cabbage	6·0		—	1·5	1·5	90	1·0
Walnut	7·5		62·5	15·5	2·0	4	7·5



The composition of some foods

I. BASIC ENERGY REQUIREMENTS AND MAINTENANCE OF BODY TEMPERATURE

The basic energy requirement is the amount of energy required just to keep all the internal vital activities of the body going, i.e. the beating of the heart, breathing, etc. It is the amount of energy required when a person is lying still and warm at least twelve hours after a meal. From experiments performed on many thousands of people the average quantities of energy required for all the vital activities alone of the body have been found to be:

Average man	1,700 Calories per day
Average woman	1,450 Calories per day

People, of course, vary enormously in all sorts of ways; some are fat, some are thin, some are tall, and some are short. All these variations have an effect on the basic energy requirements. The figure of 1,700 Calories, it must be understood, is only an average figure.

VARIATION WITH SIZE OF BODY. The basic energy requirement varies, for example, with the area of the surface of the body. The reason is this. Some of the energy needed to keep all the activities of the body going is used to keep the temperature of the body at 98·4° F. Some of this heat is constantly escaping from the surface of the body. It is just like a kettle of hot water. Heat escapes from the surface of the kettle into the air and so it gradually gets colder. The bigger the surface from which the heat can escape, the quicker it will go cold. To keep up the heat of the kettle of water, you must keep the heater on. Similarly with our body. We are constantly losing heat from our body surface, and the bigger the surface of the body the greater is the heat lost. This heat loss has to be replaced from the food eaten. Thus the bigger the surface of the body, the more energy from food will have to be taken in to keep up the temperature of the body.

The size of our body surface is closely connected with our shape. Look at the diagrams on page 240. Jack Fat and Tom Thin both weigh the same. Jack Fat has a body surface of thirty-two squares, while Tom Thin has a body surface of forty squares. Thus, although they are the same weight, Tom Thin, because he is tall, has a bigger body surface and will lose heat faster. So his basic energy requirements will be larger than Jack Fat's.

Because children have a big body surface for their small body weight, they need, for every pound-weight of their body, more energy foods than a grown-up does.

VARIATION WITH SEX. You may be wondering why an average man needs 1,700 Calories to keep his heart, his lungs, digestive system, and other vital parts working, and an average woman requires only 1,450 Calories. Again, it is a question of the loss of heat from the body. Women and girls have a slightly thicker layer of fat under the skin which helps to reduce the amount of heat lost from the body. Men and boys have a thinner layer of fat under the skin, so heat escapes more readily. Thus, to maintain their body at 98·4° F., men and boys need more energy foods than women and girls.

2. ENERGY REQUIREMENTS FOR ORDINARY DAILY ACTIVITIES. The basic energy requirement we have just been talking about is the amount of energy necessary to keep all the vital activities of the body going, when it is lying still and warm. When we start doing all our daily jobs, like getting up, washing, dressing, going downstairs, walking about, etc., we need energy for these purposes also. The amount required has been measured by scientists:

Activity	*Calories of Energy required per hour:* 9 *stone person*	10 *stone person*
Dressing or undressing	35 to	45
Sitting still	20 ,,	25
Standing	24 ,,	28
Walking slowly	108 ,,	126
Walking quickly	180 ,,	210
Running	400 ,,	470
Swimming	430 ,,	500
Dancing	180 ,,	210
Walking upstairs	800 ,,	1000

Again, you must remember that these are only average figures, but they do indicate fairly closely how much energy per hour we use when doing various activities. One

person in dressing, for example, may use more movements than another, and therefore will require more energy when dressing. It also depends on our weight, for a twelve-stone man will have to use more energy to walk upstairs than will a ten-stone person.

3. ENERGY FOR MUSCULAR ACTIVITY

In addition to the energy required to keep all our vital activities going and to perform our usual daily activities, we also require energy for the muscular activities needed for our various jobs. A schoolboy, for example, will require energy when he is using his muscles in a game of football or when he is sawing in the woodwork class. His older sister will require energy for the muscular activity entailed in typing; his mother will require energy to do her washing and ironing; and his father, engaged in hard muscular work at the docks, will want a great deal of energy for his muscular activity. The amount of energy required to perform various occupations has also been measured. Again, average figures are given in the table below.

ENERGY USED IN PERFORMING VARIOUS OCCUPATIONS

Occupation	*Calories required per hour*
Sedentary Work such as writing, typing, tailoring (i.e. when sitting)	25 to 50
Moderate or *Light Work*, e.g. carpentering, working light machine	50 to 150
Hard or *Active Work*, e.g. building, light blacksmithing	150 to 300
Very Hard or *Active Work*, e.g. coal-mining, heavy engineering, heavy blacksmithing	300 to 400

These figures are only average amounts. For example, the quantity of energy required to do a job varies with the person. A heavy person will require more energy than a lighter person to do the same job.

DOES A MANUAL WORKER NEED MORE PROTEIN? You will see that the more muscular and active the work performed, so the quantity of energy needed from food increases. In order to supply this extra energy, many people think they must eat more meat; that is, more protein. In many homes you will see the man being given large helpings of meat by his wife, while their thirteen-year-old son is given only a small amount. This is entirely wrong. The extra energy required for hard muscular work should be obtained by increasing the carbo-hydrates eaten. Proteins will provide energy, of course, but give extra work to the liver and kidneys. Also, protein foods are dearer than carbo-hydrate foods to buy. The very active worker must have a little more protein than a less active worker, naturally, for the harder work causes more breakdown of body cells and these must be replaced. Actually, it is the boy who should be getting extra protein to build up his body.

VARIATIONS IN ENERGY REQUIREMENTS DUE TO CLIMATE AND SEASONS. We have seen how the energy required by the body varies with the area of the body surface, with the age, with the sex of the person, and with his or her occupation. The climate and the seasons also affect the energy requirements.

In cold weather or a cold climate, more heat is lost than in a warm climate or season. We try to reduce this heat loss by wearing extra clothes, but in spite of this the extra loss of heat has to be made up by a greater intake of

carbo-hydrates and fats. In tropical countries where the heat loss is far less, food is required only for muscular activity and for the vital activities of the body, with smaller amounts for heat production. People living under such conditions will eat far less fats and proteins in their meals, and will obtain their energy mainly from fruits and carbo-hydrates.

DAILY ENERGY REQUIREMENTS

We have found that energy is required for the vital activities of the body, for the ordinary daily activities, and for the muscular activities necessary in the work we do. It is now possible to work out how much energy we require in a day. This again will only be an average figure. Let us take two examples; say, a clerk in a sedentary occupation, and a manual worker in an iron foundry, and find their energy requirements.

a. Sedentary Worker

		Calories
Basic energy requirements for 24 hours	=	1,700
8 hours of ordinary daily activities	=	350
8 hours of writing or work in office	=	380
Total	=	2,430

b. Manual Worker

Basic energy requirements for 24 hours	=	1,700
8 hours of ordinary daily activities	=	350
8 hours of hard muscular work	=	2,800
Total	=	4,850

From the chart on page 212 you will be able to find the quantities of energy required by various people during twenty-four hours. The quantities shown in this

table are those given by the Food and Nutrition Board of the National Research Council of the United States of America. Other people give different figures, but they agree fairly closely.

GETTING THIS ENERGY. Probably you are now saying: "This is all very well. We know we get this energy from the carbo-hydrates (sugars and starches), fats, and proteins we eat. We also know how much energy is required every day fairly accurately from the tables given. How do we know what foods we must eat and how much of them we need?" That is the problem we must now solve.

For our calculations we will imagine that the average man requires 3,000 to 3,300 Calories every day. Earlier in this chapter we found that:

1 oz. of proteins	provided 115 Calories
1 oz. of carbo-hydrates	provided 115 Calories
1 oz. of fats	provided 260 Calories

From these figures we can now work out a diet to provide the average man with sufficient energy daily. If the man eats the following quantities of proteins, fats, and carbo-hydrates daily, he will get approximately the 3,300 Calories of energy he needs:

4 oz. of proteins	produce	$4 \times 115 =$ 460	Calories
$3\frac{1}{2}$ oz. of fats	produce	$3\frac{1}{2} \times 260 =$ 910	Calories
16 oz. of carbo-hydrates	produce	$16 \times 115 =$ 1,840	Calories
		Total 3,210	Calories

The food the average man eats every day, then, must provide him with 4 oz. of proteins, $3\frac{1}{2}$ oz. of fats, and 16 oz. of carbo-hydrates. This proportion, 1 of protein, nearly 1 of fats, and 4 of carbo-hydrates, is found in practice to be very suitable. Using these figures and the diagram

and table on pages 214 and 215, we can work out the meals for a day which will contain the right amounts of fats, proteins, and carbo-hydrates to give 3,300 Calories of energy. Thus, from the table we see that lean beef is about 20 per cent protein, 5 per cent fats, and 75 per cent water and minerals. Let us calculate how much energy we get from 4 oz. of lean beef:

4 oz. of lean beef contains 20 per cent approximately of protein,

i.e. $\frac{20}{100} \times 4$ oz. of protein $= 0{\cdot}8$ oz. protein.

1 oz. of protein produces 115 Calories of Energy,

$\therefore 0{\cdot}8$ oz. produces $0{\cdot}8 \times 115 = \frac{8}{10} \times 115$ Calories $=$ *92 Calories* (approx.)

4 oz. of lean beef contains 5 per cent approximately of fats,

i.e. $\frac{5}{100} \times 4$ oz. of fats $= 0{\cdot}2$ oz. fats.

1 oz. of fats produces 260 Calories of Energy,

$\therefore 0{\cdot}2$ oz. fats will produce $0{\cdot}2 \times 260$ Calories $=$ *52 Calories* (approx.)

Therefore 4 oz. of lean beef produce $92 + 52$ Calories, i.e. *144 Calories.*

In this way we can work out the meals to give approximately the 3,300 Calories the average man requires daily:

Breakfast

Corn-flakes and milk (4 oz.).
An egg and slice of bacon.
Brown bread (4 oz.) and butter.
Tea with milk and sugar.

Dinner

Meat (4–6 oz.), potatoes (6 oz.), vegetables.
Sweet or fruit pudding (6 oz.).

Tea

Fruit and custard.
Brown bread (4 oz.) and butter.
Tea with milk and sugar.

Supper

Cocoa or milk.
Slice of bread or biscuits.

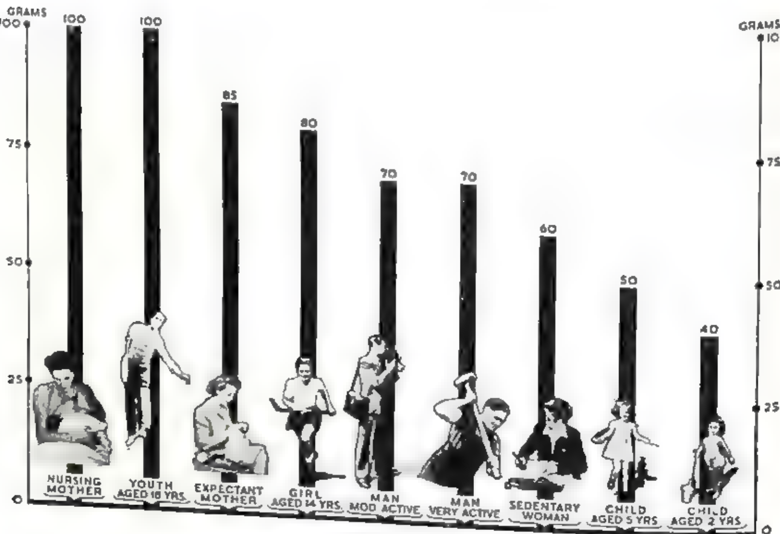
HOW MUCH PROTEIN DO WE REQUIRE? The formation of protoplasm in the structure of plants, animals, and human beings is entirely dependent on chemical substances known as proteins. Without proteins no protoplasm forms and no growth of cells takes place. You will see, therefore, that protein is absolutely essential for growth and for the replacement of worn-out cells in the body. In addition, protein is used in the body as a source of energy and heat.

The most important foods supplying us with proteins are lean meat, fish, milk, cheese, and eggs. These we call *first-class proteins*, because they are the most suitable for use by our body. Peas, beans, soya flour, peanuts, cereals, and flour also supply us with proteins. These are known as *second-class proteins*, because they are not readily available for the body to use and, in fact, should be eaten along with some first-class proteins before the body can actually use them.

(Crown Copyright. By permission of the Controller of H.M. Stationery Office)

Do you remember this picture in Book Two? What lesson does it teach?

Since proteins are mainly used by the body for growth, you will at once see that young people need larger amounts than adults. Look at the chart below. It shows the average amounts of protein required per day by various people, though these amounts will vary according to the size of the person. (The weights are measured in grams. If you wish to know the weights in ounces, it is quite easy to calculate what it will be, as approximately thirty grams equal one ounce.) From the chart you will easily see that a growing youth of eighteen years needs more protein foods than a fully grown man, even although the man is a very active worker. What may surprise you is the amount required by a woman who is nursing or expecting a baby, compared with the amount for a woman engaged in her ordinary daily activities. The reason should be clear. The



(Ministry of Agriculture, Fisheries and Food copyright)

Protein requirements per day

expectant mother needs the extra protein for the unborn baby, while the mother nursing her baby requires extra protein for the milk she produces for the baby.

During the Second World War the first-class proteins were in very short supply. To ensure that nursing and expectant mothers, and young people, got sufficient body-building foods, they were given priority and special ration cards to get extra protein foods. It was largely to make sure that children got sufficient protein that they were given free milk in school and encouraged to have school meals. Since very hard muscular work also causes a more rapid wear and tear of the muscle cells, extra protein is required to replace them. For this reason miners and agricultural workers were given an extra ration of cheese.

Before the Second World War, the poorer people had meals sadly deficient in proteins. These foods—milk, meat, cheese, eggs, and fish—were dearer than carbo-hydrates—bread and potatoes—and so were not eaten to the extent they should have been. On the other hand, richer people often ate too much protein. At dinner they had several courses, nearly all of which contained proteins.

THE MINERALS WE NEED

The body needs a number of minerals: (1) to build up bone and teeth; (2) for making blood, muscle, and liver cells; (3) dissolved in the fluids of the body for the performance of the body's activities. None of the minerals are required in the large quantities necessary for fats, carbo-hydrates, and proteins. Rather do we measure them in grams and in milligrams. A milligram is 1/1,000 of a gram or 1/30,000 of an ounce. A number of minerals are required for the well-being of the body, but we shall deal with only two, calcium and iron.

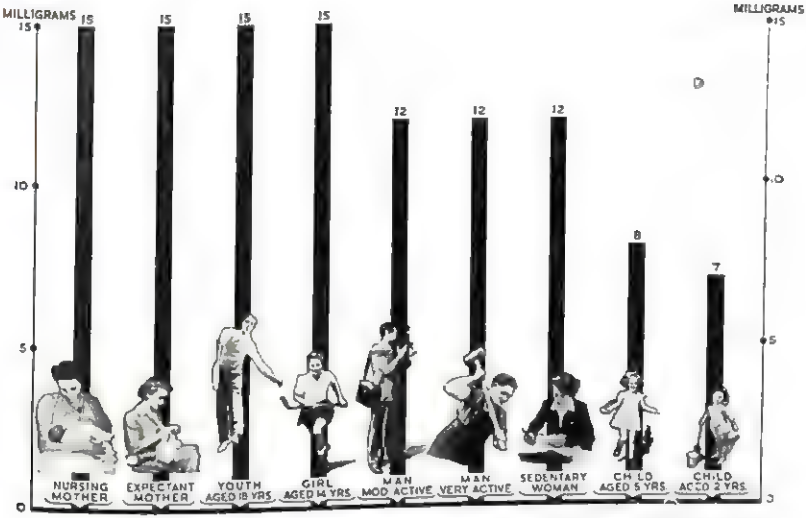
CALCIUM REQUIREMENTS. You know already that calcium is necessary for the building of teeth and bone, and therefore a good supply is essential for growing children. It has other uses in the body, too. It is necessary if blood is to clot and if our muscles are to work at all.

The main foods supplying calcium are milk, cheese, fish such as herrings and sardines (if the bones are eaten), watercress, cabbage, cauliflower, and bread which has had calcium added to the flour. "Hard" water also supplies calcium.

When we come to the amounts of calcium needed, we find that the average man or woman, no matter what work they do, requires about 0·8 gram per day, that is about 1/40 oz. Since they are growing, young people need much more, while a mother expecting or nursing a baby needs more still. If the mother is not getting sufficient, her baby will almost certainly begin to suffer from the deficiency disease, rickets. (See Calcium Chart, Book 2, p. 20.)

But even if a person, especially a growing person, is getting the right amount of calcium in his diet, another mineral, phosphorus, and vitamin D are both needed before the body can use the calcium. If a child is not getting sufficient vitamin D it cannot use the calcium it takes in for bone- and teeth-building and will suffer from rickets.

THE IRON WE NEED. When reading about the blood system in Book Two we discovered that the red blood cells contained haemoglobin, and that this haemoglobin picked up the oxygen in the lungs and transported it to all parts of the body. For making haemoglobin the body uses iron. You will see, therefore, how important iron is in our diet. If we are not getting sufficient iron our body will not be able to make haemoglobin and there will be fewer red



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Iron requirements per day

blood cells to pick up oxygen. Lack of red blood cells leads to anaemia; and the person has not the energy to carry out normal activities really well.

When the red blood cells break down, the iron from the haemoglobin is used again in the body in making more red blood cells. Some is lost during the process of digestion and also when we bleed from a wound. This loss has to be made up and we do so from the foods we eat, especially from liver, lean meat, black treacle, eggs, raisins, prunes, peaches, lentils, beans, cocoa, and spinach.

From the table you will see that men and women require twelve milligrams every day. This is a very small, but an essential, amount. Actually a woman needs slightly more than a man, because she loses some iron in the blood

regularly every month. Again, a mother nursing or expecting a baby requires greater amounts in order to supply the baby's needs in addition to her own.

THE VITAMINS WE NEED

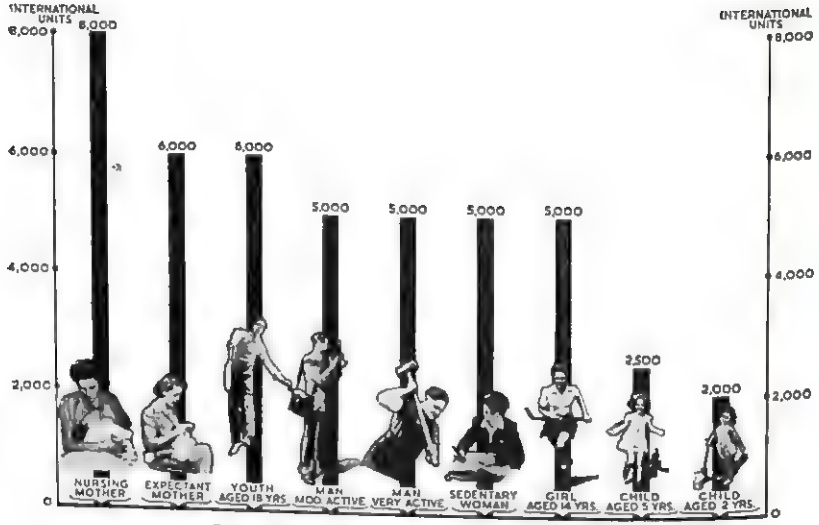
Before reading this section you should revise what you learned about vitamins in Book Two. Unlike carbohydrates and fats, which are required in fairly bulky amounts, vitamins are wanted in only very small amounts. They are chemical substances which the body cannot make for itself and yet needs for the carrying out of certain processes. (A certain amount of vitamin D can be made in the body in sunlight.) Look again at the vitamin table. This gives you the important vitamins, their uses, and what foods supply them.

If a person's diet is deficient in vitamins, then various illnesses result, as you will see from the vitamin table. The severity of the illness, naturally, depends upon how great was the shortage of the vitamin. In China, Japan, and other Eastern countries the results of severe shortage of vitamin B_1 are seen in the number of people suffering from the dread disease, beriberi. But even in the diet of many people in Britain and the U.S.A. there was a shortage of vitamin B_1 resulting in forms of neuritis. Indeed, by far the greater part of the people of Great Britain before the Second World War were not getting enough vitamins, particularly vitamin A. However, during the Second World War and since, a great deal of research has been done on the vitamins and we now know a little more (but not all) about the amounts of vitamins required.

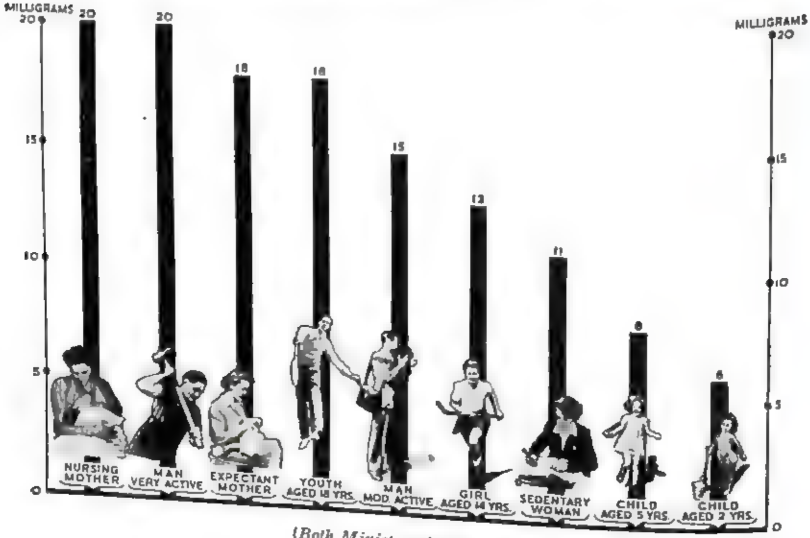
In the two charts you will see the quantities of some vitamins required by various people. One you will see is measured in International Units. This is a standard of

THE VITAMINS

VITAMIN	FOUND IN	WHAT IT DOES	DEFICIENCY RESULTS IN
A Soluble in fat.	*Halibut liver oil*, *cod liver oil*, *ox liver*, *butter*, *carrots*, dried apricots, kidney, eggs, tomato, green vegetables.	Necessary for growth in all children. Helps in seeing. Protects the skin and other moist surfaces of the body.	Night blindness. Reduction of resistance to infection.
B_1 *Aneurin.* Soluble in water.	*Yeast*, peanuts, wholemeal bread, cereals, dried peas, liver. Prolonged cooking results in loss of this vitamin, while cooking with bicarbonate of soda destroys it.	Helps in the release of energy from carbohydrates.	Neuritis, and check in growth of children. Severe shortage results in the disease of beri-beri.
B_2 *Riboflavin.* Soluble in water.	Yeast, liver, meat extract, cheese, eggs, milk.	Helps in the release of energy from carbohydrates.	Check in growth of children. Skin sores. Severe shortage results in the disease of pellagra.
B_7 *Nicotinic Acid.* Soluble in water.	Meat extract, liver, yeast, wholemeal bread, peanuts, beef, salmon, herring, cod.	Helps in the release of energy from carbohydrates.	Check in growth of children. Roughening of the skin. Digestive troubles. Severe shortage results in pellagra.
C *Ascorbic Acid*	*Fresh* fruits and vegetables, especially black currants, brussels sprouts, cauliflower, cabbage, watercress, oranges, lemons, grape-fruits, strawberries. *Also* rose-hip syrup, *fresh* liver. Cooking destroys nearly all the vitamin C. Cooking twice completely destroys it.	Necessary for uniting the cells of protoplasm together in the body. Prevents scurvy.	Scurvy. Decrease in the resistance the body offers to certain infectious diseases, e.g. boils, diphtheria, influenza. Prevention of rapid healing of wounds and fractures. Check in growth of children.
D Soluble in fat.	*Halibut liver oil*, *cod liver oil*, *herrings*, *sardines*, *salmon*, milk, egg-yolk. Also made in the body by careful exposure of the skin to sunlight.	Necessary in building up good bone and teeth. Necessary for mothers who are expecting babies, and for nursing mothers.	The disease of rickets.



Vitamin A requirements per day



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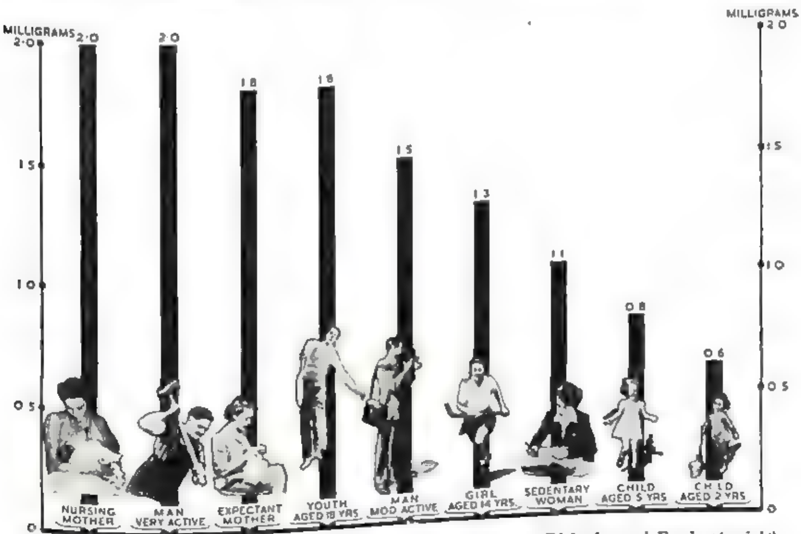
Vitamin B_1 requirements per day

a very tiny quantity which has been agreed upon for the measurement of quantities of vitamins. It is, of course, impossible for you to do anything about measuring quantities of vitamins, but if you include every day in your meals some of the foods listed in the vitamin table, you will get your supply of vitamins.

ANTI-VITAMINS. While research was being carried out on vitamins, some very important discoveries were made. These began when scientists were studying the disease, pellagra. Pellagra is due to a diet lacking in vitamin B_7, better known as nicotinic acid, and was especially widespread amongst people who ate a great deal of maize. Research workers found that even when the people who ate maize were getting sufficient nicotinic acid in their diets they still became ill with pellagra. At first they thought



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Nicotinic acid requirements per day

that there must be something toxic, that is, poisonous, in the maize, but we now know that this is not the case. Further research led to the discovery that maize contains a chemical which is very similar in chemical structure to the vitamin nicotinic acid, and which has the property of destroying or opposing the nicotinic acid. Because of this effect, this newly-discovered substance was called an *anti-vitamin*. Since this discovery other anti-vitamins have been discovered which destroy vitamin C and vitamin B_1.

What apparently happens in the body is this. To do their work, certain cells of the body require nicotinic acid. When maize is eaten the body gets the anti-vitamin instead. The cells take it in instead of the vitamin, and as a result cannot do their work. The person then has pellagra. The anti-vitamins, you see, displace the vitamins and the body therefore suffers from a deficiency of vitamins. Thus, anti-vitamins are a nuisance to us when they are present in our food.

Anti-vitamins also have their uses, however, and indeed we now use them in the fight against disease. Turn back to page 126 and read again how sulphonamide drugs work. This is a very interesting example of how discoveries in one branch of science (nutrition) are useful in another branch (the battle against bacteria).

WHAT SHALL WE EAT? By now I expect you are wondering what is the good of all this. Who wants to measure, and who could measure, all the carbo-hydrates, fats, proteins, minerals, and vitamins we need each day? It is true that this need not be done for small groups of people. If your diet is varied and includes milk, meat, cheese, fish, eggs, fruits, and vegetables as well as bread, potatoes, and cereals, you are almost certainly getting the foodstuffs you need.

But the figures are useful to us, for they do indicate where we may be wrong in our diet and what quantities we should have. Certainly, anyone who is planning meals for large numbers of people in a hospital, school, works canteen, café, or hotel should know a great deal about the science of nutrition, and be quite sure that the meals they are preparing are balanced meals.

Very soon now, you boys and girls will be young men and women. Then you will be looking forward to having a home of your own. When you have this, you should take great pride in your kitchen and in the meals you prepare. Learn all you can about food and nutrition, and see that the meals you serve are balanced meals of a good nutritional standard, attractive and nicely served. Don't let your cooking become a drudgery by serving the same dishes over and over again. Vary the dishes, experiment, and you will find this will add to the pleasure of good cooking.

THE WORLD FOOD SITUATION. So far, in talking about food requirements, we have been concerned with our own needs. We have found that the meals eaten by the average man should provide him with approximately 3,000 Calories of energy, seventy grams of protein, and smaller, but absolutely essential, quantities of minerals and vitamins. When we consider the nutritional standards of other communities and nations in the world we find that millions of people are existing on a nutritional standard far below 3,000 Calories. Hundreds of thousands die from famine, while several hundred millions are constantly faced with the threat of famine. Amongst hundreds of millions, whether faced with starvation or not, there is widespread malnutrition. This malnutrition leads to a weakening of the body resistance to killing diseases like malaria,

dysentery, plague, cholera, and tuberculosis. It is also partly responsible for the high infant mortality rate and the low expectation of life to be found in these countries.

It has been estimated that about 800 million people in Asia, Africa, and Eastern Europe rely almost entirely on a diet of rice. Millions of others eat chiefly maize, and most of these people are not getting enough rice or maize to supply even their energy wants. What is more, such a diet becomes monotonous. We get our energy from a variety of foodstuffs—sugar, cereals, bread, potatoes, fats, and proteins. We should not like to get our energy from rice or maize only and be condemned to eat these at every meal. Relying on one food, like rice or maize, has another danger in it. If the rice or maize crops fail, at once there is a widespread famine, and millions die or suffer untold misery.

These rice- and maize-eaters get few proteins, fats, minerals, and vitamins in their diets. Similarly, in many countries the quantity of meat included in the diet is very low. Since other foods which provide proteins, such as milk, eggs, cheese, and fish, also have little place in these diets, the people of these countries suffer from protein deficiency. You have probably seen stunted, wasted people of poor physique in photographs of Eastern scenes. Similarly, amongst the peoples of Asia, Africa, South America, and some European countries there is a serious deficiency of vitamins and minerals which results in extensive outbreaks of disease like beriberi, pellagra, and scurvy.

Thus we see that vast millions of people throughout the world are existing on a diet of extremely low nutritional value, and suffering always from malnutrition and the fear of famine.

WHAT ARE THE REASONS FOR THIS? By now you are probably wondering what the reasons for this are. Frequently the peoples themselves are blamed. In discussions about affairs in India, China, and other Far Eastern countries, people are often heard to say, "Oh, it's what they are used to. They are quite satisfied with rice and maize. It's what their fathers ate." This, however, is not the case. The real reason why they are condemned to exist on a rice and maize diet is a complex one.

One of the main causes is poverty. The wages earned by many Asians and Africans are dreadfully small. Such low wages do not allow these people to buy anything but the cheapest foods, and that is maize and rice. They cannot buy the foods supplying the proteins, minerals, and vitamins they need. Also, a poor country cannot afford to import food and has to rely on its own resources. If its standard of farming is low, the people will have to put up with a diet of low nutritional value and little variety.

Bad farming is another reason. In many countries the land is divided into very small holdings cultivated by the peasants. The cultivation is very primitive and the land barely produces sufficient to feed the peasant and his family. There is little variation in the crops grown and hardly any use is made of fertilisers. Certainly, there is scarcely any produce over for supplying others' needs or to provide a surplus for use in times when the harvest is bad.

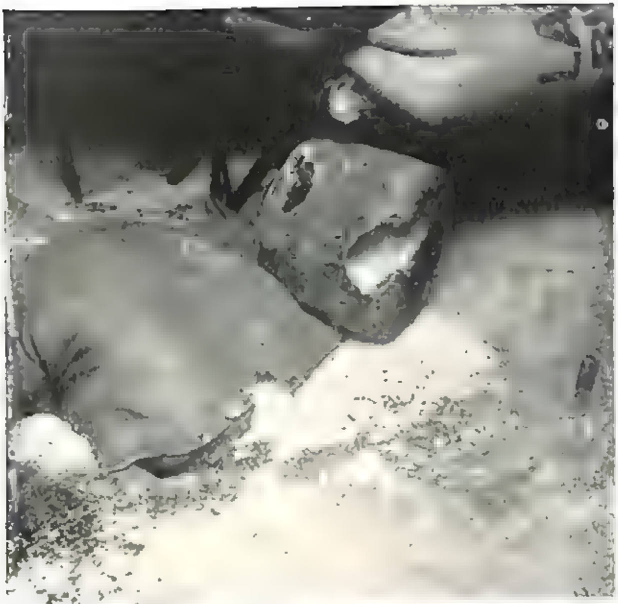
The poverty of a country, as we have seen, makes it impossible for that country to import foodstuffs. Do you see what this means? It means that only those countries which are wealthy can import a variety of food in quantities sufficient to supply their inhabitants with good meals. Thus, you see, the distribution of the world's food supply will be mainly to those countries which can afford it, and these countries contain only a small part of the world's

population. In Britain we know what effect this has on the people's food. After the Second World War Britain could not afford to buy all the food it would like. To make sure that this food was distributed fairly, the system of rationing was continued. Britain is an exporting country, and because of the big efforts made to increase production for export purposes we were able to import some foods, enough to maintain a fairly good nutritional standard. But amongst many Asian and East European countries, the export trade is too small to pay for imports, especially the import of food. Thus the inhabitants of these countries usually have a poor diet.

Another cause of the serious situation in the world's food supply is the speed with which the world's population is increasing. With an increase of about 20 million per year, you will see that the world's population (2,600 million in 1956) will have increased to about 3,000 million by 1976. This is indeed a serious matter.

Other causes of malnutrition in some places are the religious taboos placed on certain foodstuffs. Although their diet is sadly lacking in proteins, and although there are sufficient cattle to supply needs, Hindus will not eat beef because they consider the cow to be a sacred animal.

We need only mention briefly here the part played by various pests and vermin in the destruction of vast amounts of much-needed foodstuffs. The United Nations Food and Agricultural Organization states that 33 million tons of the world's supply of rice and grain for bread-making are destroyed annually by rats, fungi, and other pests. In Britain alone 2 million tons of food are destroyed by rats and mice every year. Imagine how much must be destroyed by rats and mice annually all over the world. And these are only two out of many thousands of pests of different kinds destroying growing or stored food.



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Rats like *your* food

WHAT IS TO BE DONE? You will realise now that the shortage of food in the world is a very complex problem. It is due to biological and economic causes such as poor soils and difficult climates—and also to some extent to ignorance, folly, selfishness, and lack of international co-operation and agreement. What is to be done about it? We cannot just not bother about it as we have done in the past. It is a matter of concern to us all, for all nations are now more closely linked than ever before. Malnutrition is often the forerunner of disease epidemics and unrest which spread so easily throughout the world. We must therefore get rid of malnutrition. But there is a wider view than this. Human beings are all brothers, no matter what their race, class, or colour, and the sufferings

and hunger-pangs of one group of humans are surely the concern of all.

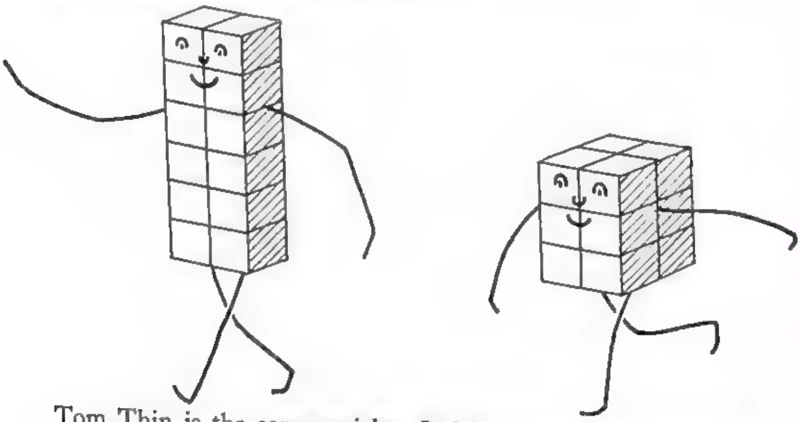
I expect that after reading the section dealing with the causes, you will be able to suggest steps that must be taken to ensure a well-balanced diet for all people everywhere. Expert biologists and agriculturists will have to be called in to experiment with new farming methods and new crops that can be grown in parts of the world at present not under cultivation. The use of fertilisers will have to be largely extended; this will mean educating thousands of people in these new farming methods and the use of fertilisers. The battle against pests, so successful in the case of the mosquito and prickly pear, will have to be further intensified and planned on an international scale. The sharing out of land as small holdings for cultivation by the peasants will have to be replaced by larger holdings which can be made to yield more productively. This may be difficult, since this system of small peasant holdings has been the method of farming for hundreds of years. One possible way out would be to encourage some of the peasant population to leave their small patches of land to work in factories. Development of industries in this way would lead to improvement in the wealth of the country and possibly open the way for an increase in imports, including food. Care must be taken that the country's own food production is at the same time increased by better farming methods. Even where such a change-over from a peasant-farmer community to a mixed farming and industrial community is not possible, encouragement must be given to the poorer communities to increase by every means possible their food production, so that they have not only enough for themselves, but a surplus which they can exchange for a variety of food imports and raw materials. Thus they will benefit themselves and contribute also to the world's food supply.

QUESTIONS, PROBLEMS, AND SUGGESTIONS

1. What are the different classes of food and what is their use?
2. What was wrong with the diet of the people of Britain before the Second World War?
3. What is meant by *energy*, *Calorie*, *calorie*?
4. Look up a physics book and try the experiments on "quantities of heat".
5. How much energy (if you could use it all) would you get from the following: 1 lb. loaf, 2 oz. butter, and 2 oz. cheese?
6. What is meant by the basic energy requirement or basic metabolism, as it is usually called, and how much energy does the average man require for this? Look up the word *metabolism* in a dictionary.
7. Why does the basic energy requirement vary with different people?
8. About how much energy will be required by the average man who walks quickly for $2\frac{1}{2}$ hours and then runs for 15 minutes?
9. Calculate how much energy can be obtained from:
   (*a*) Breakfast—4 oz. bread and 1 oz. butter, 1 oz. sugar, 3 oz. cheese.
   (*b*) Tea—egg ($2\frac{1}{2}$ oz.) on toast (4 oz.), bread (2 oz.) and butter (1 oz.), and an apple (4 oz.).
10. What are the different types of protein? How much lean meat will be required to supply the daily protein requirements of a schoolgirl aged fourteen years, and of her father who is a teacher?
11. Name two important minerals required by the body and say what they are needed for.
12. What is a *vitamin*? What is an *anti-vitamin*?
13. What changes took place in the diet of British people as a result of the Second World War?
14. Write a paper on the present world food situation.
15. Make a list of some of the causes which have led to low nutritional standards in the world.
16. Imagine you had to make a speech before the Food and Agriculture Organization, putting forth proposals for improving the standard of nutrition in the world. What would be your main points?
17. Name a drug which was recently discovered, and describe how it may help tropical Africa to produce more food.

PROJECT WORK

1. *Food Requirements*
   a. Make large charts of the tables given in the chapter for display, and write out a story to connect the whole exhibit together.
   b. Collect various foods and arrange them to represent some popular meal. By the side of each put a little card stating how much energy and what sorts of food the meal provides, and the amounts.
   c. Arrange a good breakfast and a bad breakfast side by side and make tickets to show what is good and bad about them.
   d. Make large drawings or cut out models of a growing baby, a girl running, a blacksmith, a sleeping or resting person, a walking man, a tall man standing side by side with a short, fat man. To them attach labels showing their energy requirements, etc.
2. Collect photographs, charts, and information about the world food situation and about the United Nations Food and Agriculture Organization. Make a display to show what is being done to raise the standard of nutrition in the world.



Tom Thin is the same *weight* (12 cubes) as Jack Fat, but he has a bigger *surface* area (40 squares) from which to lose heat

Jack Fat has only a surface area of 32 squares from which to lose heat although he is just the same weight as Tom Thin.

How does the shape or build of a person affect his basic energy requirements?

CHAPTER TWELVE

BIOLOGY AND AGRICULTURE

IN the last chapter, "More about Food", we learned how serious is the situation in regard to the world's food supply. Obviously, in any steps taken to increase the production of food we shall have to deal with two factors—the soil and its cultivation, and the plants and animals grown. In both these factors the biologist is keenly interested, and from his experiments and research, we are discovering ways and means of making good use of the land and producing better crops and breeding better animals. Let us now see what is being done.

THE SOIL. We have already found that soil is made up of sand, clay, decayed animal and plant remains which we call humus, and a number of minerals. Soil varies according to the proportions of sand, clay, humus, and minerals in it, and so we get all kinds of soil, from sandy soils to clay soils and peat. But soil is more than this. Living in the soil is a tremendous population of living things—bacteria, protozoa, fungi, earthworms, beetles, larvae, and even rabbits and moles. Some members of this population are of great importance. For example, without the aid of soil bacteria we could not grow plants and all life as we know it would cease.

From experiments in laboratory and field, we also know what plants take from the soil. Two biologists, Knop and Sachs, in 1862 showed that seven minerals were essential for plant growth—nitrogen, potash, phosphates, iron, magnesium, sulphur, and calcium, and that plants obtained

these minerals from the soil. Since plants are constantly taking these substances from the soil year after year, the soil will gradually become deficient in these substances and yield poor crops.

In uncultivated land this loss of minerals from the soil is made up quite naturally. When the plants growing on it die and decay, the minerals they have taken from the soil are returned. Some, of course, are eaten by animals, but even here the minerals are returned to the earth in the waste from the animals' bodies and also when they die and decay. But when man steps in, he very often upsets this balance. He grows his crops, and the harvest is consumed by man. Animals, too, which have fed on the plants are eaten. And now what happens? The waste produced is not all returned to the land. A good deal is sent as sewage to the sea and thus completely lost from the soil. Also, there is another side to this question. A nation which exports large quantities of crops and beef may be continually impoverishing her soil, for the harvests she has grown are no longer there to die and replace the minerals taken from the soil. In other words, the food-importing nations are living on the soil of the food-exporting nations.

FERTILISERS—OLD AND NEW. For hundreds of years man cultivated the earth to grow food-crops without realising that his crops were taking minerals from the soil, and that these must be replaced. He had discovered that cow and horse manures made the land give better crops, but he did now know it was partly because these manures contained the minerals that plants require. It was not till the middle of the nineteenth century that a German scientist, Justus von Liebig (1803–73), tried out experiments with artificial fertilisers to replace minerals in the soil. Almost at the same time an Englishman, Sir John Lawes (1814–1900),

began experiments on manures and produced the first really successful fertiliser, "superphosphates", in 1842.

Usually three minerals—nitrates, phosphates, and potash—need to be returned to the soil; there is enough of the others (calcium, sulphur, iron, and magnesium) in the soil to supply the needs of plants.

Potash fertilisers are mainly prepared from the deposits of potash salts in Central Europe. These deposits of potash salts were left there about 220 to 280 million years ago in the Permian Period. During this period the vast inland sea, which covered most of what is now Central Europe, dried up, leaving behind vast deposits of minerals which had been carried into this inland sea by the rivers flowing into it.

Phosphate fertilisers are made from rock deposits which Britain chiefly imports from North Africa. Bones and the slag from steel furnaces also supply phosphate fertilisers. Plants cannot absorb phosphorus directly, so the phosphate rock, bones, and slag have to be mixed and ground with sulphuric acid.

Nitrogen fertilisers are obtained from nitrate deposits in Chile and from sulphate of ammonia produced as a by-product of coal-gas. During the First World War, the blockade produced a desperate position for Germany, because Chilean nitrate of soda was not only necessary as a fertiliser, but also in the manufacture of explosives. However, a German chemist, Fritz Haber (1868–1936), had invented a chemical process by which nitrogen from the air could be combined with hydrogen to form ammonia, and this in turn used to produce ammonium salts and nitrates for use in making explosives and fertilisers. Since then the idea of using or "fixing" the nitrogen from the air to make fertilisers has been developed enormously, so that now most of the

(By courtesy of Imperial Chemical Industries, Ltd.)

The wheat on the left is growing in soil that has had a dressing of fertiliser; the wheat on the right has had none

world's supply of nitrogenous fertiliser is made by the chemical industry from the air.

GREATER USE OF FERTILISERS NECESSARY. If we are to increase the food production of the world, much greater use will have to be made of fertilisers. Even in countries like the U.S.A. and Britain, which pride themselves on their farming, too little use is made of fertilisers. But it is in the countries where the food situation is really critical that fertilisers are hardly used at all, so it is here that much can be done. Experts who have studied the position say that by the use of fertilisers rice production in India alone could be increased by 20 to 30 per cent, while similar increases in other crops could be obtained in many other

countries. Such a development in the use of fertilisers would require a big increase in the manufacture of fertilisers and the training of large numbers of farmers and peasants in their use.

TRACE ELEMENTS. Knop and Sachs showed that plants require seven elements from the soil for healthy growth—nitrogen, potassium, phosphorus, calcium, magnesium, iron, and sulphur. In 1905, a biologist, G. Bertrand, discovered that another element, manganese, was necessary for the healthy growth of oats. Later it was shown to be necessary for the growth of many other kinds of plants. Other biologists and chemists soon found that other chemical elements are necessary for healthy growth in plants. Amongst these are the elements boron, zinc, and copper. But plants need these in extremely minute amounts; that is, only traces of them are necessary. Because of this they are known as *trace elements*. It has been found, for example, that certain plants will show healthy growth if they are grown in a solution containing the usual seven elements and one part of boron in 12 million parts of the solution. Unless this extraordinarily small quantity is present, the plant growth is unhealthy.

At first all this was thought to be of interest only to biologists and chemists in their laboratories. Now we know it to be of great practical importance, for if any of these trace elements are not present in the soil, the plants growing in it will suffer from the deficiency, just as we and animals do if our diet is short of calcium and vitamins. Absence of boron from the soil causes cauliflower plants to form brown, badly developed flower-heads which are not worth harvesting. Swedes and sugar beet suffer very much if there is no boron in the soil. Shortage of manganese

in the soil causes diseases in the leaves of sugar beet, oats, wheat, and potatoes. Deficiency of copper and zinc in soil seems to have ill effects on fruit trees.

TRACE ELEMENTS AND ANIMALS. The study of trace elements in soil is important from another point of view, as we shall see from the following.

Swayback disease in lambs is thought to be due to the presence of lead in the soil or a deficiency of copper, while lack of a chemical called cobalt from soil very often leads to a type of anaemia in sheep. This is not the only example of the effect on animals of trace elements in the soil. Cattle, horses, and pigs in some of the Western States of the U.S.A. are frequently found to suffer from a serious

(By courtesy of Animal Diseases Research Association, Moredun Institute)

These two lambs were born on the same day: which is suffering from cobalt-deficiency?

disease known as "alkali-disease" or "blind-staggers". The animal loses its hair, its leg-bones are deformed, its hooves drop off, and then often the animal dies. Recently this disease was found to be due to the chemical element selenium. When the soil of the district where the disease occurred was analysed, traces of selenium were found, whereas it is absent from most soils or only present in extremely minute amounts. This selenium is taken up by the roots and so passes into the grass leaves. Animals feeding on this grass, therefore, take in the offending selenium and become victims of "alkali-disease".

There is still much to learn about these trace elements in the soil, and scientists are busy investigating them. Certainly, we do learn from this that discoveries made by the biologist and chemist in their laboratories often are of great practical use to the farmer and to mankind in general. We shall see more of this later in this chapter.

SOIL CULTIVATION. If you were to dig a deep hole in your garden or in a field you would notice that the soil was in a series of layers or strata. The top layer or top soil is usually dark in colour because it is rich in decayed animal and plant remains or humus, and therefore rich in minerals. The layer below this, the subsoil, is lighter in colour because it contains less humus, and is therefore not as good as the top soil for plant growth. Below this layer may be a third layer, the sub-subsoil, and under this, rock or clay. The depth of these layers varies considerably. In mountain districts the depth of the soil may only be a few inches, whereas in other districts it may be several feet. In the Black Earth region of the Russian steppes, its top soil may even be six feet deep.

The most important layer of the soil to farmers is the top soil. This may vary in depth from a few inches to two

(By courtesy of United Nations Organization)

Bullocks pulling a primitive plough in India

(Sport and General Press Agency Ltd.)

A tractor drawing a modern plough in Britain

or three feet. The main object of soil cultivation is to improve the quality and increase the depth of the top soil. The scattering of fertilisers and natural manures on the land is simply one way of improving the quality of the top soil. Sometimes land is sown with a crop like charlock, which is ploughed in to rot and form more humus in the soil. Ploughing is done to break the soil up and turn it over so that air and water can enter and weeds and plant remains be buried. Sometimes a special kind of plough is used after the usual ploughing has been done. This loosens the subsoil without bringing it up to the top, and enables some of the humus to mix with the subsoil and thus convert it into top soil. Earthworms assist in this by taking leaves down into the subsoil, and by bringing subsoil to the surface in the form of worm-casts, which you have probably seen on lawns. These casts are blown away by the wind and become part of the top soil. Indeed, long before man began to cultivate the land, earthworms had already done a great deal.

When man first began to cultivate the ground, he did so with primitive tools made out of pieces of wood, bone, and stone. He simply scratched the surface of the soil. For many hundreds of years this method was used, the only improvements being to scratch a little deeper and to train cattle and horses to do the pulling. It was not until 1733 that an Englishman, Jethro Tull, invented the first of the ploughs as we know them and used it with great success. The modern tractor-driven plough, however, not only cultivates the land more thoroughly, but also does it more quickly and with less labour. The modern farmer has to be more than a farmer. With the recent mechanization of agricultural implements, he has also to be an engineer or mechanic, as well as being a practical biologist.

SOIL EROSION. In cultivating the soil we must learn from the mistakes of the past. One of the most serious agricultural problems of the world today is *soil erosion*. If you had been living on a farm anywhere in the Great Plain of the United States of America in the 1930s you would have seen the sky blackened with great dust-storms for hours and days on end, when millions of tons of dry soil were lifted off the dry earth by winds and carried away. In one such dust-storm 300 million tons of top soil were blown away. By such storms millions of acres of what was once good growing land were turned into desert and wasteland. Almost 1,000 million acres of excellent farmland in the U.S.A. have been ruined by soil erosion. And it is not only in the U.S.A. that soil erosion occurs; it is going on in New Zealand, South America, Africa, and Asia. Every year huge areas of good growing land are changing into useless lands through soil erosion. It is probable that some parts of the Sahara Desert and the sandy wastes of North America were at one time flourishing with plants until disaster befell these areas.

This is, indeed, a very grave problem, and one that man will have to solve if he is to do anything to relieve the world's food situation. We must, therefore, see exactly what soil erosion is, how it occurs, and what can be done to prevent or reduce it. Let us see what happened in the Great Plain lands of the U.S.A. where millions of acres of fertile land were turned into a Dust Bowl.

EROSION BY WIND. The prairie lands had for many years been good grassland on which great herds of bison fed. After the American Civil War, large numbers of farmers and land companies began to make their way into this area, hoping to get rich quick. Some ploughed up the land and began to grow wheat, while others grazed huge herds of

cattle on the land. But in their greed to get as much out of the earth as possible, they were storing up trouble for themselves and for future generations. The big herds of cattle ate up the grass and left little covering on the surface. The constant heavy cropping with wheat left the earth poorer and poorer in minerals, so the crops also became poorer and poorer. This also left a sparse covering for the soil. When the wheat was harvested and the land was ploughed, the soil was left entirely uncovered. All this prepared the way for disaster. There was a drought, as there frequently is in parts of the Great Plain. The top soil became as dry as dust, was lifted off the earth and carried away by the wind. This was deposited in drifts and great heaps, which often buried other farm buildings and farms, or was blown out to sea, or scattered uselessly far and wide. All that was left was the poor subsoil on which no crops would grow. Large numbers of families were ruined and left their farms.

(By courtesy of United States Information Service)

This farm in Texas is buried beneath sand that once was fertile top soil in nearby cotton fields

These disasters are not confined to the Dust Bowl of the U.S.A. Huge grasslands in Brazil and other South American countries are being ploughed up to grow other crops, and the same terrible story is being repeated. And not only in South and North America, but in Africa, China, and other parts of the world, bad farming which leaves the soil with no covering crop is leading to ruin by soil erosion.

EROSION BY WATER. Perhaps you have been in a mountainous district and seen great gullies in the sides of the mountains and hills, especially in mountains of red sandstone. These gullies or channels have been worn by water running down the mountain-side. Gradually the channel or gully is worn deeper and deeper, the sides crumble, and great quantities of soil are carried down to the river in the valley and washed out to sea. On its way down through the lower slopes it may pass through cultivated fields and change what was once useful farmland into useless waste.

Even on land which has only a gentle slope, water will cause erosion. This has happened in the U.S.A. and other countries on a vast scale. When the gently sloping plains were under grass the soil was bound together by the roots and the water was retained. When the land was ploughed and wheat crops grown, there was less to hold the water. A gentle flow of water ran into the ditches and streams, carrying with it the fine particles of soil. Although this is a slow process, over a huge area millions of tons of the good top soil can be washed down to the sea in a year. But more than the soil is lost. The rain-water dissolves the valuable minerals in the soil and vast amounts of these are carried away to sea out of the reach of food-crops. It is in this way that the sea has become salt in taste from the huge quantities of salt washed out of the rocks and

Erosion by water made this hillside useless

(Photos by courtesy of United States Information Service)

Eighteen months later the planting of trees has stopped further damage

earth over millions of years. It was in this way that about 250 million years ago the deposits of potash and other minerals were made in the inland sea in Central Europe.

FORESTS AND SOIL EROSION. Forests supply us with timber, but they do more than this. The floor of a forest is composed of a dense mass of decayed leaves or humus. This behaves like a sponge, so that when rain falls much of the rain-water is retained and not allowed to run away. This is especially valuable on sloping lands, for it helps to prevent soil erosion and the formation of deep gullies. On the lower slopes of a forest-covered hill-side, farmers can cultivate their land free from anxiety, knowing that the forest floor will hold the water and prevent damage by erosion.

Forests also perform another useful service. Trees take in water from the soil in order to get the minerals dissolved in it. They take in more than they can use, and so they transpire or give out quite large quantities as water vapour through the pores in their leaves. From an extensive forest a vast quantity of water vapour goes into the atmosphere. When this meets cold air it condenses, forms clouds, and finally falls as rain. Thus a forest can influence the local weather and be a means of preventing drought. In countries where forests cover great areas, you will see how important this may be, and how carefully any cutting down of the forests must be done.

Again let us turn to the United States of America to see what happens when man interferes. Trying to get rich quick, men began to cut down the trees in great quantities, so that large parts of the land have been deforested. In some districts after the trees have disappeared, the land has been ploughed and sown with wheat. I hardly need tell you what the result has been. When the snows melted

and the rain came there was no forest floor of humus to retain the water. So on it went down the hill-sides washing away the good earth, carrying valuable minerals out to sea, and bringing ruin to thousands of farmers.

This story is being repeated in Brazil and in large parts of Africa where forests are recklessly destroyed, and heavy rains more easily wash away good soil down to the rivers and seas.

PREVENTING SOIL EROSION. This is a matter of vital importance to the whole world. We cannot allow land necessary for food growing to go to waste and become useless desert land. Steps must be taken to prevent further erosion and also to bring back the eroded lands under useful cultivation. Let us see what can be done. Two things are required—first, moisture must be kept in the soil, and secondly, some covering crop must be kept on the soil. Here are some of the methods that can be used to achieve these purposes:

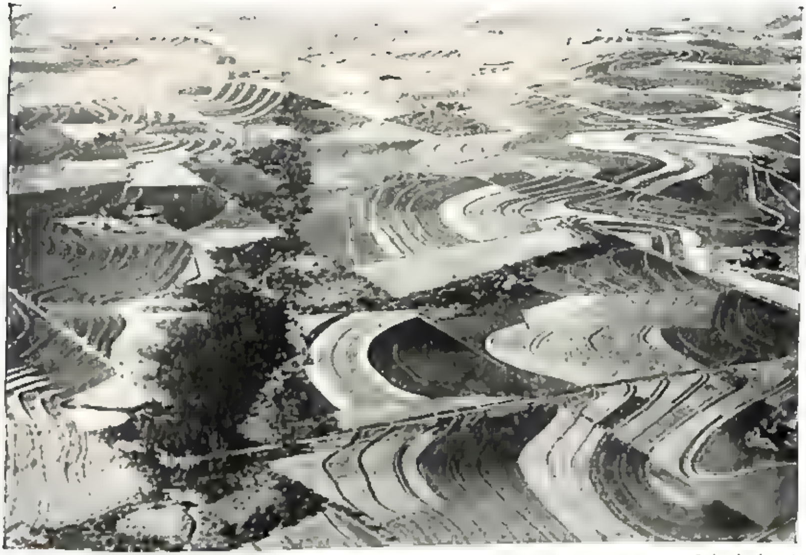
1. Humus and decaying plant remains which absorb water must be kept in the soil.
2. Grass can be grown to form a cover. Even on land which has already suffered from erosion or has been abandoned, grass can be grown during the wet periods. This, if maintained for some years, will make the land fertile again, gradually building up a new layer of top soil.
3. Farmers in districts where soil erosion is likely to take place should grow a variety of crops, making sure that every part of their land will be left under grass for some period.
4. Strict control must be kept on the number of cattle grazing on grassland in soil-erosion areas to prevent too much grass being eaten.

(By courtesy of United States Information Service)

Streams have made gullies in this once fertile land in the prairies of North America

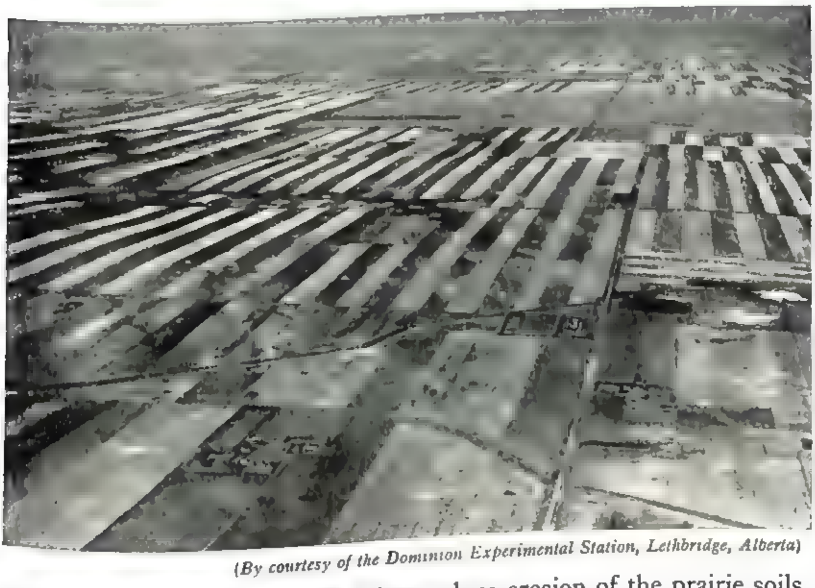
(S. P. Jackson)

Here is a great gully spoiling the grazing in the Orange Free State in South Africa



(By courtesy of United States Department of Agriculture)

Ploughing along the contours and planting different crops alongside each other in strips stop erosion on these strange-looking plains of Texas



(By courtesy of the Dominion Experimental Station, Lethbridge, Alberta)

Alternate strips of wheat and fallow reduce erosion of the prairie soils of Alberta

5. Crops can be grown in strips, so that if the soil does blow off one strip, it may be reduced by the next strip, which may be under grass or stubble.
6. Belts of trees can be grown to act as wind-breaks to prevent soil blowing and also to reduce evaporation which can be helped by wind. The trees will also help to retain snow-drifts, which on melting will supply water.
7. To stop water running down a hill-side, the land is ploughed along the hill-side and not up and down. The furrows then help to retain the water.
8. Terraces, too, are often built along the hill-side so that it has the appearance of steps. The land is levelled for a strip several yards wide, then a five- to ten-foot wall is built, and at the foot of this another level strip.
9. When trees are cut down for timber, young trees must be planted to take their place.

In the United States of America and in other countries useful work in preventing erosion is being carried out by the Soil Conservation Service. By lectures, booklets, and the appointment of watchers, a great deal is being done to educate farmers and settlers in ways and means of preventing and combating soil erosion.

WHY IS THERE LITTLE SOIL EROSION IN BRITAIN? Hundreds of thousands of square miles of the earth have been ruined by soil erosion. Fortunately, there is little occurring in Britain. This is mainly because we do not often have torrential rain or long periods of drought. There is some erosion going on. In some of our valleys examples can be found. In the upper Swansea Valley deep gullies, formed

by water rushing down the mountain into the River Tawe, can be seen. Normally the river is crystal clear, but after heavy rain, so much sandstone is washed down that the water becomes thick and brown like soup. You may see similar erosion in your district. If you ever go to the Lake District, see if you can find any there.

Another reason why little erosion is taking place in Britain is the fertility of the soil. This yields good crops and the humus formed knits the top soil into a texture which holds water.

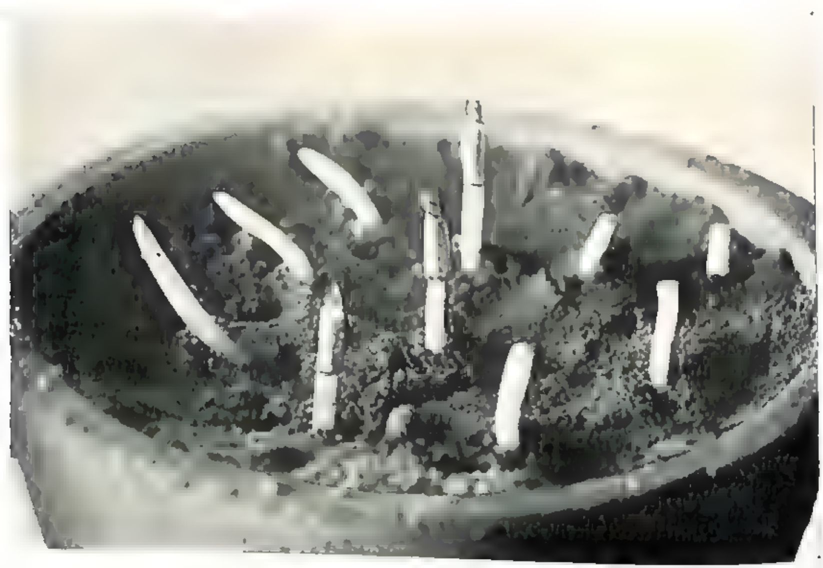
THE SOIL POPULATION. So far we have been concerned entirely with the mineral content of the soil. We must not forget there is also in the soil a vast population of living things. The number of micro-organisms is amazing. In one gram of soil, that is, about enough soil to cover a silver threepenny-piece, there are from 100 million to 3,000 million bacteria, 1 million protozoa, and about 100,000 moulds!

All this teeming life plays a vital part in the growth of plants. As we have already seen in Chapter Four, plants could not live without soil bacteria to help in preparing minerals for their use.

THE PLANTS WHICH GROW IN THE SOIL. Biologists are extremely interested in plants. They want to know what is going on inside a plant, and how plants grow and feed. So in their laboratories and out in the fields, they experiment on plants and study them intently. Some of their discoveries are of interest to biologists only, but other discoveries have been of great importance to man generally, and have been put to practical use. Let us consider some of these discoveries which have proved to be of practical value to all mankind.

AUXINS IN PLANTS. If you have some seedlings growing in a plant pot placed near a window, I expect you have noticed that the seedlings bend over towards the light. If now you turn the pot round so that the seedlings point to the darker interior of the room and leave it for some hours, you will find the seedlings once more bend towards the light. Now try this experiment.

Fill two plant pots with soil, and in each sow some maize, grass, wheat, or mustard-seed. Place both pots near a window and keep the soil moist. Immediately the seedlings are just peeping through the soil, carefully cut off the tips of the seedlings in one of the pots. After several days observe what happens, and if you have a school photographic society get one of its members to photograph the result. You will find the seedlings with the tips cut off continue to grow upright, but the others will curve towards the light.



(From Skaife: The Outdoor World Book 6)

Which seedlings have not had their tips cut off or covered with silver paper?

For many years scientists have made all kinds of suggestions to explain why plants should bend towards light. The experiment you did shows that it must be something in the tip which causes it, but it is only recently that the reason has been discovered. It is due to a chemical produced in the tip which regulates the growth of the plant. Because of this we call the chemical an *auxin* from a Greek word which means "to increase" or "to grow". When light falls on the tip the auxin moves to the part of the stem on the darker side and causes this side to grow more. Thus the stem bends over to the light. Scientists have been able to extract the auxin from the tips of plants, and have been able to produce chemicals with the same effect on plants as auxin.

This auxin behaves like the chemicals in our body which we call "hormones" or "chemical messengers". You may remember that when we were studying digestion of food we found that as the food leaves the stomach to go to the duodenum a tiny quantity of a hormone is released into the blood. The blood takes the hormone to the pancreas. This causes the pancreas to send pancreatic juice on to the food in the duodenum. The hormone acts as a chemical messenger, telling the pancreas when to send out the pancreatic juice. Similarly, the auxin produced in the tip of the stem causes growth at another spot in the stem. Since this first discovery, other auxins have been discovered in plants.

AUXINS AND ROOT GROWTH. Further experiments showed that auxins not only controlled or regulated the growth of stems, but also of the roots of plants.

Perhaps you have tried to root cuttings of black currants in the school garden or at home. Have you ever wondered why these cuttings of stems should form roots? We now believe that an auxin is produced in the buds of the cuttings, and that this passes down the stem and causes the

(By permission of Kenneth V. Thimann, R. H. Lane, and the American Journal of Botany)

Which of these pine cuttings have formed the best roots? The top four on the left were given no auxin, the top four on the right were treated with a weak solution, the bottom four on the left with a stronger solution, the bottom four on the right with a very strong solution.

roots to grow. Not all plant cuttings will root as easily as black currants will. Some, indeed, never seem to take root. However, if these cuttings are dipped in a solution containing auxin, they will very soon begin to produce roots. Scientists have gone further than this. They have produced in their laboratories chemicals which have the same effect as the auxin, and these are now being sold under various trade names. Here, then, is the first practical application of the discoveries of scientists in plant growth. Cuttings of plants which would not root are now made to do so by the application of these chemicals.

Following on this work it was discovered that germinating seeds treated with auxin produce more roots than usual and that this leads to healthier and better growth. Experiments have been tried with oats, and it was found that the seeds treated with auxin produce better plants with better heads of oats.

(By permission of Kenneth V. Thimann, R. H. Lane, and the American Journal of Botany)

The oats at the top have grown from seeds not treated with auxin while those below have grown from treated seeds

HORMONES WHICH DELAY GROWTH. Hormones which delay growth in plants have been found, and scientists have produced in their laboratories chemicals which have the same effect and which are now being used in agriculture.

When potatoes are lifted from the fields they are stored in clamps until they are wanted for market. Often while in the clamps they begin to sprout and become unfit for sale. In some countries earth or paper strips are impregnated with one of the chemicals for delaying growth, and spread amongst the potatoes in the clamps. This prevents the growth of the shoots on the potatoes, and so keeps them fit for sale.

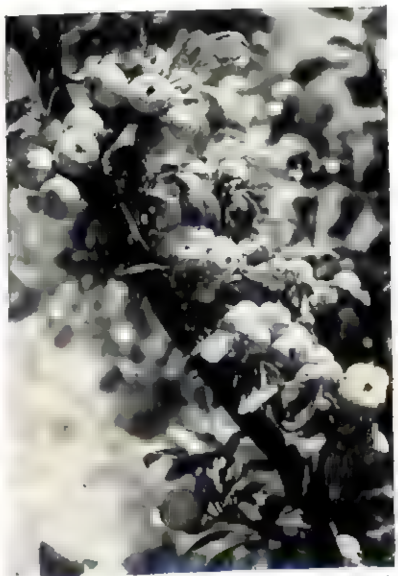
PREVENTING PRE-HARVEST FALL. If you have any apple trees in your school garden or at home you will know that the apples on some trees fall off before they are properly ripe. In a fruit-growing district where orchards are large, this can be a serious matter. What happens is this. As autumn approaches a layer of cells grows across the stem of the apple, and so weakens the stem that the apple falls. Frequently this happens before the apple is fully ripe. (The same process causes the leaves to fall in autumn.)

Biologists have discovered that an auxin and certain chemicals will delay the growth of cells. Thus it is possible to prevent the apples falling before they are really ready. This is done by spraying a very weak solution (about ten parts to a million of water) of one of these chemicals on the apple trees.

SEEDLESS FRUITS. You know that if we want apples to form on our apple trees, the flowers on the trees in the spring must be fertilised. When the eggs or ova in an apple blossom are fertilised by pollen from another apple blossom, the ova develops into seeds and the fleshy ovary

round the ova develops into the apple that we eat. This, of course, is true for other plants as well as apples. We cannot have the apple without the seeds.

Biologists discovered that pollen was rich in a plant hormone or auxin, and that this auxin caused the fleshy part of the apple to grow. Having discovered this, they tried to obtain the auxin or to discover chemicals which had the same effect. This has been done, and by treating the blossoms with these chemicals the ovaries have been caused to develop without the seeds developing. Thus we have a seedless fruit. The experiment has been tried successfully on apples, pears, melons, tomatoes, and pineapples. It has to be done by experts, otherwise the fruit is ruined.



(By courtesy of Long Ashton Research Station)

When this apple tree was sprayed with a growth-promoting substance the fruitlets remained on the tree in spite of severe frost and turned into the beautiful crop you can see on the right

SELECTIVE WEED-KILLERS. Weeding is a tiresome business, even in a small garden, and no doubt, when you have been hoeing weeds out or pulling them out by hand, you have wished that someone would invent something that would kill weeds without killing the peas, lettuces, or other plants which you are growing. Your wish has now come partly true, for scientists have discovered chemicals called "selective weed-killers" which will kill some plants and not harm others. Weeds are a serious matter in agriculture, for they interfere with growing crops, and often are the plants on which disease micro-organisms spend part of their life. The introduction of selective weed-killers is, therefore, a matter of great importance.

In 1896, a French vine-grower had noticed while spraying his vines with Bordeaux mixture to kill pests, that the spray killed weeds growing amongst the vines. It was the copper sulphate in the Bordeaux mixture which apparently was responsible, and gradually farmers began to spray copper sulphate solution over their fields where wheat and other cereals were growing. This did no harm to the cereals, but killed the weeds, especially charlock or wild mustard. Dilute sulphuric acid was also used as a spray. Both these sprays were effective because the solution lodged on the broad leaves of the weeds, but ran off the young shoots of the cereals, since they were protected by the waxy sheath that grows round them in the early days of growth.

While experiments were being carried out on plant hormones, scientists observed that the hormones and the chemicals which behaved like plant hormones killed many plants if used at certain strengths. This has been developed further, and now there are on the market several selective weed-killers which farmers can spray on their fields to kill the weeds without harming cereal crops.

Similar work was being carried out in other countries,

(By courtesy of Plant Protection)

One strip in this field of oats was not treated with a selective weed-killer: which is it?

especially the U.S.A., and it has recently been reported from Puerto Rico in the West Indies that weeding has been carried out successfully amongst sugar-cane and coffee by means of these new chemicals.

The advantage of these new selective weed-killers is that they are non-corrosive, easy to handle, and need be used only in small amounts. For example, to make a spray sufficient to kill charlock in an acre field, only one pound of one of the new weed-killers is necessary, whereas it would take 130 pounds of sulphuric acid.

The use of these selective weed-killers will do something towards increasing the world's food supply. Experiments have shown that increases of 20 to 50 per cent in a crop have resulted from weed-killing treatment. It is economically sound also, for in spite of the cost of the weed-killers, the income from the increased yield is much greater.

BREEDING PLANTS AND ANIMALS. We are now going to turn our attention briefly to a branch of agriculture which has benefited greatly from the research work carried out by biologists—the breeding of plants and animals. We have already discussed this in Chapter Twelve of Book Three, so that it will only be necessary to mention briefly what has been done.

NEW PLANTS FOR OLD. If we could bring back to life one of the New Stone Age men who cultivated his wild grasses for food, he would be vastly amazed to see our modern fields of golden oats and wheat with their big yields of grain. So, indeed, would Sir Walter Raleigh if he saw the potatoes we now grow. By careful selection and now by scientific breeding we have produced plants which give greater yields and are more resistant to disease. By crossing a wheat subject to rust but giving a good yield, with an immune wheat of poor yield, biologists produced a resistant wheat of good yield which they then crossed with another wheat which gave a good-quality flour. Thus by painstaking experiments these biologists have

(Crown Copyright. By permission of the Controller of H.M. Stationery Office)

Rust-resisting wheat. In the lower part of the photograph you can see the parent wheat, American Club, from which it was bred. Why did Professor Biffen use American Club as the parent wheat in some of his wheat-breeding experiments?

produced wheats such as the Little Joss and Yeoman varieties which are resistant to disease, give a good yield, and a good quality flour.

This type of work is being done with other crops—potatoes, turnips, tomatoes, rice, and maize—and is being further extended. Plants are being produced which are able to grow where the growing season is short and where the climate is very dry or cold. For example, wheats have been produced which will grow farther north than ever before. In this way the area of the earth available for wheat-growing is being extended, so that man will benefit by an increase in the world's wheat supply.

Herds of cattle that can give good beef and milk need plenty of grass to feed on. Until recently farmers were satisfied as long as there was sufficient grazing for their beasts. Now, however, research scientists, such as Sir George Stapledon and his fellow-workers at the Welsh Plant Breeding Station at Aberystwyth, have shown that the quantity and the quality of the beef and milk yield depend a great deal on the careful cultivation of grassland and on the types of grass grown. By careful breeding and selection they have produced grasses suitable for various purposes—for grazing, for hay-making, for pastures, and for mountain-sides. These grasses have made great improvements in the grasslands. This in turn has been of great benefit to cattle and has led to increased yields in milk and beef.

X-RAYS AND NEW PLANTS. In the search for better plants scientists are working along new lines. In 1927 an American discovered that when cells were exposed to X-rays certain changes or mutations could be produced in the chromosomes. It is these chromosomes which are responsible for the various characteristics of living things.

The size, shape, colour, and quality of an apple, for example, depend upon the chromosomes in its cells. If these can be altered by X-rays, the characteristic features of the apple may be altered, and thus it may be possible to produce larger and better apples. What is more, this quality will be passed on to the apple trees grown from the seeds. This has actually been done. By exposing various fruits to X-rays and selecting any which show new good qualities, better fruits have been produced.

Similar changes have been brought about by treating seeds and plants with chemicals, particularly one called colchicine, obtained from a flower, the autumn crocus. Colchicine causes the chromosomes in the plant cells to double in number, and this leads to bigger plants and fruits. It has not yet been put to practical use, but further work is being carried out. Experiments have already been tried on treating the seeds of giant redwood trees in California, U.S.A., with colchicine in the hope of producing bigger trees still.

NEW ANIMALS FOR OLD. As in the case of plants, man has carefully watched his sheep, pigs, cattle, and hens, and selected those he considers best for breeding purposes. This has on the whole led to a gradual improvement in our animal stock. Through the discoveries of Mendel and the study of heredity, breeding has become a matter of science and we have advanced a great deal in the production of better types of farm animals. By crossing various types of cattle, biologists have produced new breeds of cows giving a higher yield of milk and butter fat, and a greater number of calves, while other crossings have produced cattle giving more beef. For example, by careful breeding from cows with a high milk yield, a breed of cows which give a milk yield of 100 gallons of milk a year more has been

(Farmer and Stock-Breeder Photographs)

Lambs and cows today look very different from and are much more valuable to man than their ancestors 100 years ago

produced. Experiments have also been carried out on breeding cattle suitable for special climates.

But it is not only in the breeding of new livestock that scientists are interested. They have been called in to find why some cows fail to have calves, and some of their discoveries here are of practical benefit to the farmer and to mankind generally. For example, scientists found that cows deficient in calcium and phosphorus and vitamin E are often sterile; that is, do not produce calves, and that food containing these minerals would put the trouble right. Other scientists interested in the nutrition of animals have discovered that overfeeding can lead to sterility in cows.

Thus the biologist, the chemist, and other scientists are working quietly and without any fuss in their laboratories and experimental plots and fields. Their work seems to have no connection with the everyday life of the farm or the tremendous problems of the world's desperate food situation. Yet from their discoveries, new ways of increasing the world's food supply are found, new ways of making the life of man on earth freer from want, freer from worry, freer from disease.

Experiments you may like to try

1. Look up the experiments on soil in Book One, and use them to analyse various soils in your neighbourhood.
2. Look up the experiment (Book Two) on growing plants in culture solutions and repeat it.
3. Arrange with your gardening teacher to perform the following experiments:

(1) *Manurial Experiment No. 1*

If you have a large school garden, measure out twelve plots, 12 feet by 12 feet. Dig them over carefully. For the experiment use some recommended variety of potato and, after choosing potatoes of approximately the same size, plant the same number in each plot. Apply fertilisers to each plot in accordance with the plot opposite in the usual way. When using mixtures of fertilisers, use them in the following proportions:

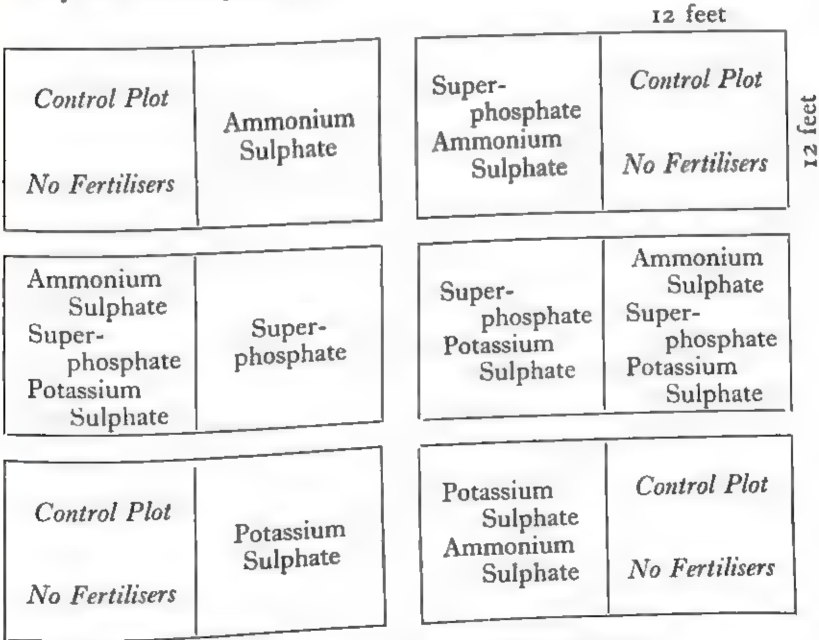
Ammonium sulphate	1 part	3 oz. per sq. yard
Potassium sulphate	$1\frac{1}{2}$ parts	
Superphosphate	3 parts	

When using one fertiliser alone use the following amounts:

Ammonium sulphate alone	$1\frac{1}{4}$ oz. per sq. yard
Potassium sulphate alone	$1\frac{1}{2}$ oz. per sq. yard
Superphosphate alone	$2\frac{1}{2}$ oz. per sq. yard

Label each plot clearly and record all your observations with great care throughout the experiment. When the potatoes are lifted note any differences, and weigh the potatoes from each plot after separating them into ware or eating potatoes, seed or smaller potatoes, and chats or potatoes too small to use except as pig food.

Make a complete record, including photographs, notes, graphs, statistics and posters. The experiment should be repeated in the same way on the same plots over a number of years to get accurate results.



PLAN FOR MANURIAL EXPERIMENT NO. 1

(2) *Manurial Experiment No. 2*

For another experiment using both artificial fertilisers and natural manures, the plan opposite will show you how it can be arranged. Carry it out in the same way as Manurial Experiment No. 1.

(3) *Effect of sodium nitrate on lettuces*

Measure out two plots, say 6 feet by 3 feet. Cultivate them carefully until you have a fine tilth. On to each plot transplant the same number of lettuce seedlings. Apply carefully sodium nitrate to one plot at the rate of ¼ oz. per square yard, but not to the other plot.

During the experiment record any observations you may make, and when the lettuces are ready, take them up, wash them carefully, and weigh them. Take photographs of the experiment.

(4) *To find if weeds affect a crop*

Obtain a variety of wheat either from an agricultural store or a local farmer, and also, if you can, some charlock or wild mustard-seed. You may have to collect these seeds yourself from charlock plants you see in the country.

Now prepare three plots, about 15 feet by 6 feet, and sow them as follows:

Plot A. Wheat only.
Plot B. Wheat only.
Plot C. Wheat and charlock.

Keep plot A weeded as far as is possible, but do not weed plots B and C.

Note down any observations you may make during the process of the experiment. When the wheat is ripe, gather it from each plot, measure the average height, and weigh the yield of heads. Take photographs of the experiment and of the end result.

(5) Buy some packets of plant-growth substances or auxins from a horticultural shop or stores, and try out experiments with them on rooting cuttings.

(6) Try the experiment given in the chapter on the bending of plants towards the light.

12 feet

7½ feet

Plot No. 1 (10 sq. yards) *Control Plot* *No Manure*	Plot No. 2 Farmyard Manure (20 tons per acre = 92 lb. per 10 sq. yards)
Plot No. 3 Garden Compost (20 tons per acre = 92 lb. per 10 sq. yards)	Plot No. 4 Ammonium Sulphate (2½ cwt. per acre = 9 oz. per 10 sq. yards) Sulphate of Potash (2½ cwt. per acre = 9 oz. per 10 sq. yards) Superphosphate (6 cwt. per acre = 22 oz. per 10 sq. yards)
Plot No. 5 Farmyard Manure (10 tons per acre=46 lb. per 10 sq. yards) Ammonium Sulphate (1½ cwt. per acre=5½ oz. per 10 sq. yards) Sulphate of Potash (1½ cwt. per acre= 5½ oz. per 10 sq. yards) Superphosphate (4 cwt. per acre=14 oz. per 10 sq. yards)	Plot No. 6 *Control Plot* *No Manure*

PLAN FOR MANURIAL EXPERIMENT NO. 2

WORK TO DO

1. Write a two-minute paper on the need for increasing the food production of the world.
2. What minerals do plants want mostly from the soil?
3. If you have a school garden or there is a farm near the school, find what fertilisers are used, in what proportions they are mixed, how much is used, and when.
4. What do food-exporting countries lose?
5. From an encyclopaedia find all you can about Sir John Lawes, and the work of Rothamsted Experimental Station. Write a paper on this to read to the whole class.
6. When and how did the deposits of minerals in Central Europe form?
7. How are most nitrogen fertilisers produced now, and how and when did this method come into use?
8. Why must fertilisers be used more extensively?
9. What is a trace element? Give an example of one and its effects on plants.
10. What is the purpose of cultivating the land?
11. What is meant by soil erosion and how is it caused?
12. What has been the effect of soil erosion?
13. How can soil erosion be prevented or stopped?
14. What is the value of forests to the farmer?
15. How can cuttings be caused to root more successfully?
16. How can potatoes be prevented from sprouting in clamps?
17. How can the fall of fruits before they are quite ripe be prevented?
18. How can seedless fruits be produced?
19. What is meant by a selective weed-killer? Name some and say how they work.
20. How has the work of biologists in the breeding of new plants and animals been of great value to mankind?

PROJECT WORK

1. Make several visits to a farm at various seasons throughout the year. By photographs, plans, and written work make a record of the year's work on the farm.
2. If you live near an experimental or horticultural station or a seedsman's nursery, arrange a visit. Observe the work being done there, and make a report on it.
3. *Fertiliser Display*
   a. Make a collection of different fertilisers and arrange them to form a display. In addition, make posters giving information about each fertiliser and its uses.
   b. Perform the manurial experiments given earlier and use all the material you gathered from the experiments in a display.
4. Arrange a display showing farm tools through the ages. Make use of illustrations, photographs, and models.
5. *Soil Erosion Display*
   Collect photographs, maps, and information about soil erosion and make posters. Use models to further illustrate your work. This display should show:
   a. The soil erosion areas of the world.
   b. Wind erosion.
   c. Water erosion.
   d. Effect of cutting down forests.
   e. Ways of preventing soil erosion.

CHAPTER THIRTEEN

BIOLOGY AND THE HOME

LOOK ROUND YOUR HOME. Before we start studying this chapter look round your own home. Look carefully and try to find the answers to these questions:

1. What type of house is it?
2. How many rooms does it contain?
3. Look round each room carefully, and make a list of its good points, and another of its bad points.
4. Did the builder and designer of it make a good job of it?
5. If you are not satisfied with it, how would you improve it?
6. What type of house would you like to live in, and why?
7. What fittings would you like in the kitchen?
8. Are there good facilities for storing, preparing, and cooking food?
9. Is there a lot of unnecessary work connected with your home?
10. Are the cupboards placed conveniently or have you to stretch or bend awkwardly to use them?
11. Is your house damp? If so, what has been done to reduce dampness?
12. Is the water system liable to freeze up in winter?
13. Is the hot-water system efficient?
14. Is your house satisfactorily lighted?
15. Is the ventilation efficient?

(By courtesy of the Northern Ireland Housing Trust)

New houses in a new estate in Belfast

When you go to a friend's house for tea for the first time, almost certainly your friend will take you on a conducted tour round the house. "This is the sitting-room or parlour," she will say. "This is the living-room or dining-room. It's quite nice, but a bit dark and draughty." So the inspection goes on, and, of course, you agree with all your friend says about the house.

Now let us visit a house, but this time as biologists looking out for what is right and what is wrong from a biological standard. Before we enter the house let us look round the outside.

Is the site of the house a good one? Is it too isolated and too far from the shopping centre? Is it easily accessible? All these are questions that must be considered. From a health point of view the best site for a house is one which:

(*a*) has a dry soil, porous to water;
(*b*) is slightly elevated to allow for good drainage and good circulation of air;
(*c*) is open and sunny;
(*d*) has a south-east aspect for the front to allow for maximum sunshine.

Of course, in most cases we cannot choose the house we would like to live in. But if we are not satisfied with our present dwelling, we should move whenever possible to one that is more satisfactory, keeping in mind the points mentioned.

DAMPNESS. One of the most common faults of housing and one that is responsible for much ill health is dampness. This may be because the house is built on a non-porous soil which does not allow the water to drain away, or because the site is on a low level into which the water from the neighbourhood drains, or because the house is badly built.

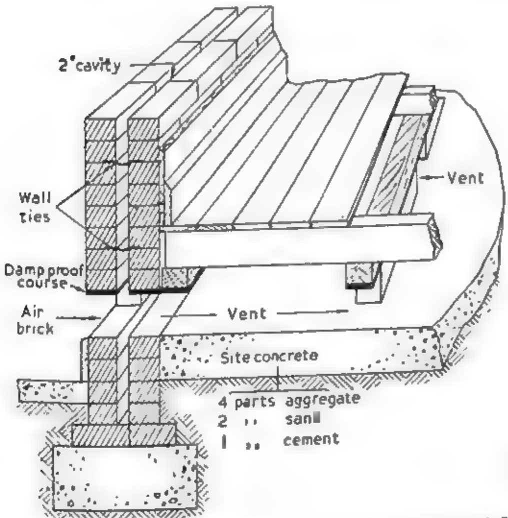
A simple experiment will show you that bricks absorb a great deal of moisture. Weigh a dry brick, then stand it for some time in two or three inches of water. After several hours take the brick out of the water and weigh it again. You will find it has gained greatly in weight from the water it has absorbed. You will thus see how important it is to take precautions to prevent dampness entering the house through the bricks or rising from the ground through the bricks.

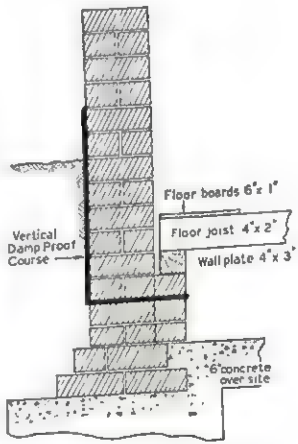
To prevent dampness, four precautions are usually taken:

(*a*) provision of a damp-proof course in the wall;
(*b*) building of a cavity wall;
(*c*) provision of a ventilation space between the foundation and the floor-boards, and the use of ventilation bricks or gratings in the wall;
(*d*) concrete over building site.

Look at the illustrations and you will see where to find these in your home. The damp-proof course consists of some material which will not allow water to pass through.

As well as preventing dampness, these precautions help to prevent "dry-rot" destroying the timber of a building.

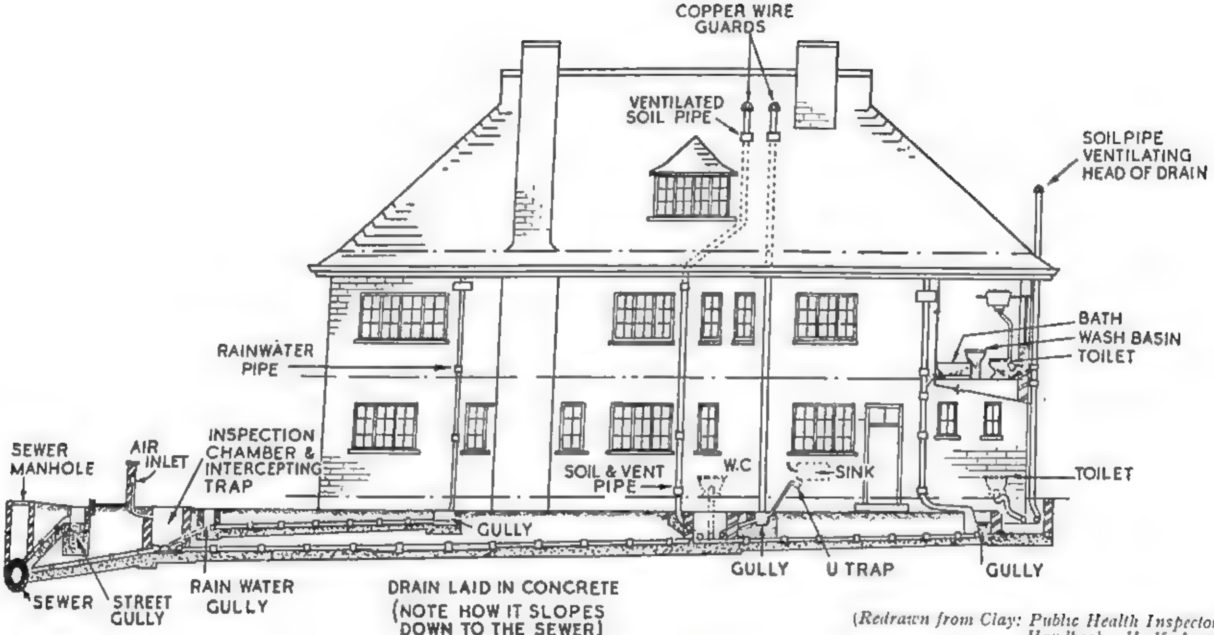




(*Both redrawn from Clay: Public Health Inspector's Handbook—H. K. Lewis*)

Damp-proof course, cavity wall, and ventilation of space below floor

Horizontal and vertical damp-proof course for solid walls



(Redrawn from Clay: Public Health Inspector's Handbook—H. K. Lewis)

The drainage system of a house

Dry-rot is caused by a fungus which needs a dark, damp, still atmosphere for its growth, and thus often attacks floor-boards in a house. If a ventilation space between the floor-boards and the concrete over-site is provided, conditions can be made unsuitable for the growth of the fungus, and dry-rot will be prevented. When digging or raking is being done in the garden, care should be taken not to block up the ventilation gratings in the wall with soil or weeds.

DRAINAGE. Now let us look round the outside again, this time to inspect the drain-pipes, gulleys, and grids. With the introduction of good drainage systems in houses to take away waste solids and liquids, typhoid fever and plagues and deadly epidemics have almost disappeared.

Drain-pipes are made of non-porous pipes jointed together to prevent any leakage. They should be laid with sufficient slope to allow the waste water to run along with sufficient force to wash out any solid waste. To prevent any foul gases from the drains entering the house, various types of traps are used. Under the sink and lavatory bowl there is a U-pipe which is always full of water to act as a trap. The water from the kitchen sink and the bath discharges into a grid outside the house. In this grid there is also a U-bend or gulley.

Perhaps you have seen an iron pipe rising out of the ground and going up by the side of the house. At the top there is a wire basket. This is a ventilation pipe for the drains. It is put there so that a current of air can enter the drains and cause air movements which help to free the drains of accumulations of foul air and gases. You will be able to guess the purpose of the wire cage at the top.

Here and there around the outside of the house you may

have seen iron plates in the ground or paths. These are the covers over the inspection chambers which provide a means of inspecting and cleaning the drains.

Now study carefully the diagram of the drainage system of a dwelling-house. See if you can find the ventilation pipes, and all the means taken to prevent foul gases entering the house from the drains. When you have done this, look all round your house, and learn all you can about its drainage system.

Now let us enter the house, and visit first the kitchen.

KITCHEN. In many houses the kitchen is a cold, cheerless, uninviting room. Yet this is the room in which the housewife spends a good deal of her time. A dull, dismal, draughty kitchen dampens her spirits, makes her work burdensome, imposes unnecessary strain on her nerves, and is the cause of much ill health. Therefore, the kitchen should be decorated in bright, cheerful colours, have large windows, be free from draughts, and yet be well ventilated. It should be a reasonable size, for there is nothing more irritating to the nerves than a small kitchen in which one is constantly knocking over things. Good lighting is very important. If the stove and the baking-board are in dark shadow, this causes eye-strain and may lead to accidents. The window and lights should be placed so that there are no shadows, and so that the housewife has no difficulty in seeing or doing the jobs she has to do.

Up to the First World War, kitchens were rarely planned at all. This meant that the housewife in her kitchen work had to perform a lot of unnecessary and awkward movements, with the result that she suffered from fatigue and her work became a burden. Now, with the introduction of many labour-saving devices and the careful planning of

(*Picture Post Library*)

An up-to-date kitchen 100 years ago

the kitchen, the work has been very much lightened and time saved. For this purpose, the cooking utensils should be kept near the cooker, the baking materials near the baking-board, and the sink should be at a convenient height from the ground and underneath the window.

An essential in the home is adequate food storage space. In some houses this forms part of the kitchen; in others it is close to the kitchen. It should be in a cool place, well ventilated, and well protected from houseflies and other pests. The food storage is often ventilated from outside

through a wire mesh, which should be fine enough to keep out dust as well as flies. Refrigerators are excellent for keeping milk, cream, eggs, and other foods.

In many houses, there is no provision for drying clothes indoors if washing-day happens to be wet. This often means the washing has to be brought into the living-room and dried before the fire. This is very unhealthy, as the room and the air in it become very damp and uncomfortable. For this reason there should be some means of drying clothes in the kitchen.

(By courtesy of the Council of Industrial Design)

An up-to-date kitchen today. Name all the improvements you can see

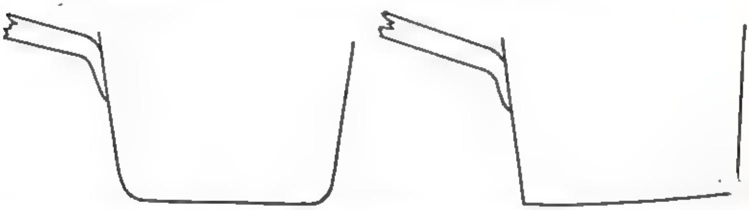
Now there is the important matter of hygiene in the kitchen. Since the kitchen is the place where the preparation and cooking of food is carried out, it is here that there

is greater opportunity for contamination of the food by micro-organisms. The increase in cases of food-poisoning observed during recent years is largely due to carelessness in the kitchen. Every part of the kitchen should be spotlessly clean and kept in good repair. It should be possible to move the cooking and other appliances so that the space behind them can be cleaned. Any holes and cracks should be filled in to prevent mice and other pests entering. The sink needs particular attention. It should be washed regularly, and now and again boiling water with washing soda dissolved in it or some disinfectant should be poured down the waste-pipe. A sink-tidy should be used so that tea leaves, peel, and bits of food do not go down the waste-pipe. It should be possible to unscrew easily the screw-cap at the bottom of the U-pipe underneath the sink to facilitate cleaning. (Very often this is painted over, which makes it difficult to unscrew.) Separate cloths should be kept for washing dishes, sinks, floors, and walls; and these and the tea towels should be frequently boiled. Too often tea towels are used over and over again without any boiling.

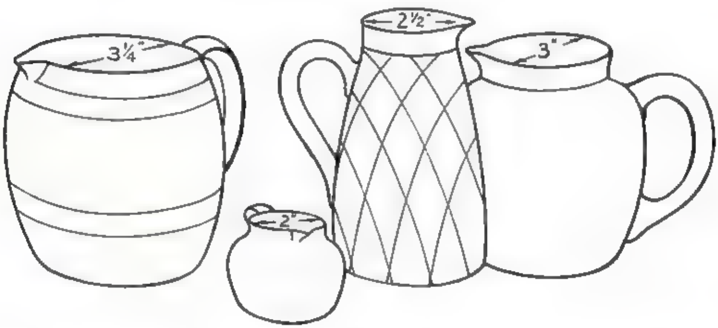
The washing-up should be done really well, using plenty of hot water and soap to get rid not only of the grease, but also the micro-organisms. The modern washing materials, known as detergents, do this very effectively. After the washing, the dishes should be rinsed thoroughly. Cracked crockery especially should be thoroughly washed, since it harbours large numbers of bacteria in the cracks. It is more hygienic to replace the cracked dishes. When the washing-up is finished, the sink and the washing cloths should be rinsed out with hot water and left perfectly clean.

The pots, pans, and other kitchen utensils should be pleasing in design, labour-saving, and also free from little

spaces and awkward corners where grease and dirt may lodge. The metal-ware should be stainless and rustless. Think carefully when buying such utensils.



Here are the sections of two pans. Which one do you think will be more difficult to clean? Which is the more hygienic?



Some jugs are badly designed from a hygienic point of view. They have awkward corners and rims that cannot be cleaned properly. Stale milk lodges in these places and becomes a breeding ground for bacteria. Which of these jugs would you consider unhygienic?

It is a good idea to cover the kitchen shelves with new white shelving paper. Every time the kitchen is cleaned, this paper should be burned and replaced by new paper.

The bin for kitchen waste should always be covered with a lid and kept as far away as conveniently possible from

the kitchen window, so that there is less danger from houseflies. It should be emptied regularly every week. If it is not, then a complaint should be sent to the local health authorities.

But a clean kitchen is not enough. It is equally important that the person concerned in the preparation of the food and in the washing-up should be clean in person and habits. It is most important that after a visit to the toilet the hands should be thoroughly washed before handling any food or dishes. Failure to do this is the most serious cause of food-poisoning. Care should be taken by a person suffering from a cold or cough not to spread infectious micro-organisms to the food by coughing or sneezing, or from the hands which have been in contact with the nose. Such a person should really not be engaged in preparing food.

Finally, the kitchen is probably the best place for keeping the home first-aid box, since it is in the kitchen that frequent burns and cuts are met with. The box should contain, amongst other things, acriflavine, bandages, lint, cotton wool, safety-pins, an eye-bath, splinter forceps, a small pair of scissors, bicarbonate of soda for burns, and anti-sting lotion. A burn should not be covered except by some sterilised linen to prevent any infection, until it is seen by a doctor or nurse. Such a piece of sterilised linen can be prepared quite easily. Wrap one or two pieces of clean white linen in some strong, clean white paper. Place it in a hot oven until the paper begins to char. Wrap the whole in another clean piece of paper and put away in the first-aid box ready for any emergency.

LIVING-ROOM. This is the room where the whole family are most often gathered together, and it should, therefore, be a large room. It is very irritating when people get in

one another's way. It must be large enough also to provide play space for the children. Overcrowding in the living-room is largely responsible for the many burning accidents which occur in homes. Where there are children fire-guards must always be used. This is true also for electric or gas fires, which should have one or two narrow bars in front of the hot wires or burning gas for protection.

The living-room should have good window space and receive as much sunlight as possible. If unfortunately it is a dark room, it should be decorated in bright, cheerful colours. It should be pleasingly and adequately furnished, but should not develop into a showroom, so that the family hardly dare to use it. There should not be too many ornaments in the room, as these only harbour dust and add to the work of cleaning and dusting. Look at some illustrations of Victorian homes. You will see the walls covered with pictures, and ornaments of all descriptions occupying every little space.

The living-room, more than any room, should be free from draughts, though well ventilated. It is very unhealthy and annoying to find one cannot sit down in the living-room without feeling draughts. Most frequently these are due to ill-fitting windows and doors. If they cannot be made to fit, draught excluders and other devices can easily be fitted.

BEDROOM. It is always pleasant to have the bedroom where it will get the morning sun. Probably more important still, however, is that it should be in a quiet situation, so that few noises from the street are liable to disturb one's sleep. The decoration should be restful and soothing. A very important point is the ventilation, which should be adequate for the purpose and free from draughts.

(Gernsheim Collection)

A living-room 60 years ago

(By courtesy of the Central Council of Industrial Design)

In how many ways is this modern room better?

(Humphrey and Vera Joel)

Which of the furnishings are likely to collect dust?

BATHROOM. This should be decorated in bright colours with the walls tiled or painted with glossy enamel so that they can be washed easily. The bath must be so fitted that no dirt can lodge underneath or behind it. If the room is heated by electricity the heater should be fixed in a safe place. Anything damp acts as a good conductor of electricity. The switch for the heater or the light should be either outside the room, or, if it is in the room, it should be the kind worked by a length of insulated cord. This is very important, for many people have lost their lives through carelessness in the use of electric fittings in the bathroom.

The best time to have a bath is just before going to bed. If you have your bath at any other time, you should not go out of doors immediately. The hot water will open your

sweat pores; cold air can easily get in them and you will catch a chill. If you have to go out, the hot bath should be followed with a quick sponge down or shower in cold water which will close the pores quickly. When you have finished your bath, see that it is washed out thoroughly so that no scum or dirt is left sticking to the sides.

(Humphrey and Vera Joel)

Why is this bathroom easy to keep clean?

LAVATORY. The excreta or waste from our body contains vast numbers of micro-organisms, and it is essential that it should be washed from the lavatory bowl into the drain as quickly as possible. The pan should be made of a highly

glazed or non-absorbent material and should be so shaped that the excreta falls directly into the water and not on the sides. The bowl should contain water to seal off the drain and allow for the rapid disposal of the excreta. The flushing system should provide a rapid supply of water sufficient to flush out the excreta and cleanse the bowl. When you use the lavatory see that you leave it in a clean state and not in any way contaminated with waste from your body. The bowl should be kept clean and some disinfectant poured down at frequent intervals. Do not forget to wash your hands after you have used the lavatory, especially if you are going to prepare or eat food.

STORE-ROOM. It is inconvenient to have the cleaning materials lying in odd corners about the house, and dangerous too, for someone may easily trip over them. They should be stored in a cupboard, which in most houses is under the stairs. This should be easily accessible and also easily cleaned out.

STAIRS. The stairs should not be too steep and should be fitted with a handrail. Since it is on the stairs that many accidents occur through missing a step, they should be very well lit. Loose stair carpets are very dangerous, so care should be taken that they are fastened down safely.

COLOUR IN THE HOME. Within recent years scientists have been engaged in studying the effects of colours on human beings. They have made some important discoveries, which are now proving of value in the factory. Colour, if correctly used, can stimulate production, lessen fatigue, make people cheerful, and lessen the risk of accident. The amount of light reflected from the walls on to the work

benches and machines is increased if the walls are painted with the right colours.

Similarly, colour can play an important part in the home, and can give an atmosphere of cheerfulness or restfulness or be a very disturbing factor.

Walls decorated with light colours, such as cream, yellow, apricot, or pink, give a feeling of warmth and an air of freshness to a room. Yellow, provided it is not overdone, always gives the feeling of warm sunlight and cheerfulness, and is especially useful in a room which gets little sun. Green is very restful to the eye and nerves and can be used effectively. Red colours are very stimulating, but they are also very tiring to the eye, and therefore should be used with care. Blue gives the feeling of coldness and should not be used extensively, especially in a living-room.

Care should be taken to see that the walls, furnishings, and floor form a pleasing picture. Clashing colours and shades are very disturbing and give a feeling of restlessness. Colours can also be used to make a room look larger or smaller than it really is. Blues and greens, for example, tend to make a room look larger, while reds have the opposite effect.

When you choose your colour schemes, you should only do so after much careful deliberation. Think first what the room is to be used for, the effect you want to produce, the situation of the room, the type and colour of the furniture to be placed in it. Remember that you will have to live with that colour, possibly for some years.

LIGHTING IN THE HOME. Sight is our most important sense, and we get far more news of the world around us through our eyes than through any other of our sense organs. If an object is sufficiently lighted we can see it easily and quickly. If an object is badly lighted, dimly or glaringly, we run the

risk of eye-strain. This eye-strain will in turn cause headaches, affect our nerves, and also our health and welfare. Indeed, to sit reading or doing some job in a bad light is not only harmful to the eyes, but also makes us feel miserable.

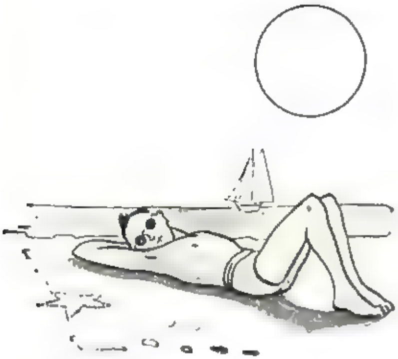
By using an instrument called a "lightmeter" scientists can measure the amount of light falling on a table or book or other object accurately. The light is measured in units called *lumens*, and a lumen is the amount of light given by a standard candle at a distance of one foot. Look at the illustrations showing the intensity of light, both outside and inside the house, and note the great variation. As a result of experiments the illumination values shown in Table A have been given for various parts of the house. They are minimum values and can be increased with advantage.

TABLE A

Location	*Total Wattage*	
	Filament Lamp	*Fluorescent Lighting*
Hall	60	30
Landing	60	30
Stairs	60	30
Passages	60	30
Living-room (general)	120	80
Easy chairs	100	30
Writing table	100	30
Sewing table	100	30
Dining-room (general)	120	80
Kitchen (overall)	200	80
Bedrooms (general)	100	40
Bedhead	60	30
Bathroom	100	40

(By courtesy of the Lighting Service Bureau (E.L.M.A.)

The intensity of light is measured in *lumens*. A 40 watt bulb gives about 450 *lumens* at a distance of one foot



1. In June at mid-day the sun may give up to about 10,000 lumens per square foot or degrees of light. Too much perhaps for eyes accustomed to an indoor life

2. In a porch, probably because not more than two sides are open to the sky, the illumination falls to something in the region of 500 lumens per square foot

3. Inside a window the illumination is again lower, probably about 200 lumens per square foot

4. At night, however, many people have inconveniently placed lighting which may give no more than 5 lumens per square foot

(By courtesy of the Lighting Service Bureau (E.L.M.A.))

We have also to remember that some colours reflect a good deal of the light that falls on them, while others reflect only a little. Thus, a wall painted white will reflect much more light back into the room than a red wall or even a pink wall. Table B will tell you how one colour compares with another in reflecting light.

TABLE B

Position	*Colour*	*Reflection Factor per cent*	*Position*	*Colour*	*Reflection Factor per cent*
Ceiling	White	84	Floor	Light Stone	53
	Pale Cream	73		Middle Buff	43
	Pale Peach Pink	65		Dark Stone	41
Wall	Deep Cream	70		Tan	35
	Primrose	70		Medium Brown	25
	Light Buff	60		Sage Green	20
	Portland Stone	55		Peacock Blue	17
	Eau de Nil	50		Maroon	15
	Peach	50	Miscellaneous (Dado, sills, doors and skirtings)	Golden Yellow	62
	Light Grey	45		Sky Blue	47
	Egg Shell Blue	45		Grass Green	20
	Salmon Pink	42		Nigger Brown	15

(By courtesy of the Lighting Service Bureau (E.L.M.A.))

Good lighting not only prevents eye-strain, but is also one of the best means of protection against accidents. Well-placed lights of adequate illumination will reduce accidents on the stairs and in passages, and lessen the number of burns, scalds, and cuts in the kitchen. Good lighting in the kitchen leads to more efficient cooking and washing-up, and shows up any dirt.

Have you ever noticed how many people shut out light by using heavy or dark curtains or putting a tall piece of furniture in front of the windows? Curtains are, of course,

attractive, but they should be chosen and draped so that they allow as much daylight as possible to enter. Sunlight is a very effective killer of micro-organisms and should be allowed to enter the room.

HEATING IN THE HOME. Most homes are heated by coal fires in open grates. Although it is very pleasant to sit by a blazing fire, it also has its disadvantages. There is the constant cleaning necessary, and the occasional need for a chimney-sweep. But the worst fault is the pouring out of volumes of smoke into the atmosphere. Smoke pollution of the air is responsible for many respiratory illnesses, blackening of buildings, fogs, and much hard work and more expense in washing curtains, table-cloths, and other materials blackened by soot. No doubt some of you will have heard your mother grumbling about the soot and smuts to be found everywhere in the house. However, by recent improvements in the structure of fire grates and in slow-combustion stoves and grates, something has been done to reduce the smoke menace.

Of course, smoke pollution could be reduced still further if gas or electric fires were used more widely. Some people find them inconvenient for use over a long period. Their heat is a "dry" heat. If they are used, care must be taken that there is no leak of gas and no danger from electric shock.

A method of heating that is smokeless and does not cause a "dry" atmosphere is what is known as "panel" or radiant heating. This is done by a system or panel of pipes hidden in the ceiling or walls and heated by hot water or electricity. The advantages of this method are that there is no dusty fire-place to clean, no dirtying of walls, the heating is not a "dry" heat, so there is not the feeling of a stuffy atmosphere, and there is little danger

(*By courtesy of the Coal Utilisation Council*)

Warm air is retained in a room when a coal fire has a restricted throat

(*By courtesy of Fibreglass Ltd.*)

Roof insulation keeps the house warmer and prevents burst pipes

These boilers are sufficiently powerful to heat a large building; both boilers and pipes are well insulated

(*By courtesy of Ideal Boilers and Radiators, Ltd. and the County Architect, Surrey County Council*)

from burns. The heating, too, is distributed about the room more evenly than with coal, electric, or gas fires.

DUSTING IN THE HOME. Have you ever been in a room into which a beam of light enters? You will probably have noticed how the beam shows up the dust floating about in the air. This dust consists of particles of earth, ash, soot, tiny fibres of woollen and cotton material, and also bacteria and moulds.

Dust, if breathed in, irritates the throat and is a source of infection from the bacteria in it. It must therefore be removed from the house by dusting and sweeping. This needs to be done carefully, as some methods of dusting do not remove the dust but simply scatter it. Windows and doors in a room should be closed a few minutes after carpet-sweeping and after the fire-place has been done, to allow the dust to settle. Then the room-dusting can be done. The duster should be folded into a pad, and not just flicked about to scatter the dust. The use of a mop is not advisable, since it scatters dust about. It is better to use a good carpet-sweeper or vacuum cleaner. When the dust has been swept up it should not be put in a bin, but wrapped in an old newspaper and burnt.

Every spring sees many women busily engaged in what they call "spring-cleaning". They go through each room and turn everything upside down! So thoroughly do some housewives engage in this work that they become physically and mentally exhausted, and everyone in the house is inclined to become bad-tempered and annoyed at being disturbed. It is a good idea to clean the house thoroughly every so often, but it is bad when it has these bad results. It is possible to plan the cleaning and spread it over a period of time, so that it does not become an exhausting burden and a source of worry.

(By courtesy of the Harlow Development Corporation; plan redrawn from Master Plan of Harlow New Town prepared by Frederick Gibberd, C.B.E., F.R.I.B.A., M.T.P.I.)

Each house should be a real home: a group of homes should form a community. Can you suggest some ways in which the planners of a New Town can help to foster a sense of community?

WHAT MAKES A HOME? But a home is more than a house, kitchen, living-room, furnishings, and colour schemes. There is also the family living in the house. It is the family which makes the house into a home. When people talk of a good home or a bad home, they do not mean a well-built house or a badly built house. They are talking about the family living in the house.

What do we really mean by a good home? We mean a family which is living in harmony and happiness; a family in which each member is loyal and devoted to the other members; a family in which each member is not trying to get as much as possible out of the others, but seeks to do all he can for the others to make their life more enjoyable and satisfying. In a good family each member is pleased at the success of any other member. If any member of the family is faced with trouble and worry, the rest of the family seek to comfort him, to share his burden, and protect him against further misfortune.

This sharing of one's joys and sorrows makes life a source of happiness, and the idea that one belongs to a group or family which cares for one gives one a feeling of security.

A child born into such a home will receive the affection and the understanding he needs. He will be given the care and attention necessary for his physical well-being. He will not be repressed, but will be encouraged to handle objects around him and by doing things himself he will satisfy his need to create and make things. At the same time, he will gradually learn that he is not a law unto himself, but that he is one of a group, and cannot do all he likes or would like to do. Thus he learns to adapt his behaviour to fit in with the rest of the family. For any good work he will be praised, and urged on to greater achievements.

Thus we can say a good house provides shelter, but a good home provides not only shelter, but parental care and love and family affection.

But, unfortunately, there are also many bad homes. Homes in which the members are not living happily together; homes in which the members are constantly quarrelling and arguing; homes where the members are living in an atmosphere of strain and distrust. There is little or no sharing of pleasures and triumphs, while in trouble and distress, little sympathy is shown. In such a home there is little feeling of security.

In this kind of home a child will not have a fair chance. He will probably be deprived of parental love and the proper care and attention he requires. He is likely to be slapped and bullied when he does something which the other members of the family dislike, or harshly told not to do this or that. Parents exert a great influence on the mind of a child, and their behaviour towards a child plays a great part in the formation of its character. In a home where there is little love between parents, and between parents and child, the influence will be a bad one and may be reflected in the child's character. Finding no security, no praise and encouragement in the home, he may become a miserable, morose, and self-centred person. Seeing other children living happily, he may resent his own circumstances, and seek revenge for his treatment, not always on his family, but on other people. He may begin to steal, to bully, and to develop into a juvenile delinquent. By this bullying and stealing to possess things, he seeks to get the security which his home fails to give him. Thus the poor home and lack of parental care are responsible for the wrecking of a human life.

In a few years' time you will be young men and women and no doubt will be falling in love. When *you* fall in

love, get to know the person you love really well. Find out if your interests are the same, and whether you will make good companions. That is what courtship is for; to find out if you both will form a happy, unselfish partnership, sharing one another's joys and sorrows and enjoying true companionship. This is very important, for on the choice of a good partner depends the type of home life and family life you may build up. Married to a partner lacking in good character, you are running the risk of ruining your own future life, a broken home, and raising children in an atmosphere of hatred and sorrow. Married to the right companion, you have every possibility of raising a happy family in a good home.

WORK TO DO

1. What would you consider a good soil and a bad soil on which to build a house? Give your reasons.
2. What houses in your district do you think are built on a good site?
3. Is there anything wrong with the site of your house?
4. What steps are taken to prevent dampness in a house?
5. If you get the opportunity of seeing a house being built, watch what is done to prevent dampness.
6. Find out what materials are used to make a damp-proof course.
7. What is "dry-rot" and how can it be prevented?
8. Go round your house and note where the drain-pipes, the gulleys, the ventilating pipes, and inspection chambers are.
9. What precautions are taken to prevent foul gases from drains entering your house?
10. If a drain is blocked or smells, what should you do to have it attended to?
11. Find out from history books how drainage systems developed.
12. Look round your kitchen and then make a list of its good points, and another of its bad points.
13. How would you improve your kitchen?
14. Design what you would consider a good kitchen.
15. Examine the pots, pans, and other utensils in your kitchen, the school kitchen, and in shops. Draw and describe any you note of a good hygienic pattern.
16. What would you include in a first-aid box for the home?
17. What would you say are the important features of a good living-room?
18. What is the danger from electrical apparatus in the bathroom?
19. Does your lavatory flush and cleanse itself in a really efficient manner? Why is it important that it should?
20. What colours do you like best? Do you agree that colour does exert some influence on a person?
21. Plan the colour schemes for a kitchen, living-room, bathroom, bedroom, and hall.

22. If you can get hold of a lightmeter, test the lighting in various parts of a number of rooms and passages with the lights off and on. Record your observations. Test the light given out by various lamps.
23. What may be the result of insufficient lighting in the home?
24. Do you find the heating of your home, school, and club-room satisfactory? If not, what would you do to improve it?
25. What is your opinion of spring-cleaning? Is it a satisfactory method of keeping the house clean, or have you any better ideas?
26. What is meant by an unhappy home life or a broken home? What influence may such conditions have on the people concerned?

PROJECT WORK

1. Using models, actual building material, experiments, photographs, plans, and charts, make a display to show the steps taken to prevent dampness in a house.
2. Design and make an exhibition of drainage and sanitary fittings in the home. Use models, plans, actual fittings, and wall charts. Include a section on the primitive types of drainage and lavatories still in use in the country. This exhibit may well be enlarged by including the historical development of household and town drainage schemes.
3. Make a comparative exhibition of a good and a bad kitchen from hygienic, labour-saving, and aesthetic points of view. Use plans, models, photographs, and charts.
4. Make a display of (*a*) unhygienic and badly designed kitchen utensils, and (*b*) hygienic and well-designed kitchen utensils. This may also include crockery. Use posters to show the dangers from unhygienic and ill-designed utensils and crockery.
5. In conjunction with your history, art, and domestic science work, make a display entitled "Colour in the Home". The display could be arranged as follows:
   - *a*. The theory of the use of colour.
   - *b*. Colour in the home.
   - *c*. The use of colour in the home throughout history.
6. Obtain material and information concerning light in the home. Using these, actual displays, photographs, your own designs, experiments, and models, make an exhibit on "Lighting in the Home".
7. Make a similar exhibition on "Heating in the Home".

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